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SYSTEMATIC ZOOLOGY: ITS PROGRESS AND PURPOSE *

IT is most fitting that in this year, when the scientific world is commemorating the natal centenaries of two naturalists who have been regarded as the chief systematists of their times, consideration should be given to the subject and object of their old pursuits. Carl Linné, whose bicentenary has been celebrated, was the man who first provided an elaborate code of laws for the nomenclature of all the kingdoms of nature and set an example to others by provision of concise and apt diagnoses of the groups and species he recognized. Louis Agassiz, who was born during the centenary year of Linné, gave a grand impulse to the study of nature in his adopted country, raised it in popular esteem, taught new methods of work and directed to new lines of investigation.

Of all the students of nature from the time of Aristotle to the century of Linné, none requires present notice as a systematic zoologist except John Ray, who was the true scientific father of the Swede. Born in 1627, he flourished in England during the last quarter of the seventeenth century, and died only two years before the birth of Linné.

JOHN RAY

It was long ago truly affirmed by Edwin Lankester that "Ray has been pronounced by Cuvier to be the first true systematist of the animal kingdom, and the principal

* Address before the Section of Systematic Zoology, Seventh International Zoological Congress.

guide of Linné in the department of nature."¹ He, indeed, made a pathway in the zoological field which Linné was glad to follow, and to some extent he anticipated the brightest thoughts of the great Swede. He, for example, in a dichotomous systematic table of the animal kingdom,² first combined the lunged fish-like aquatic and viviparous animals in a special category (*Vivipara*) in contrast with all the other vertebrates, leaving to Linné only the privilege of giving a name to the class. He recognized a group of lung-bearing animals distinguished by a heart with a single ventricle, including quadrupeds and serpents, and thus appreciated better than Linné the class which the latter named *Amphibia*. He likewise gave the anatomical characters, based on the heart, blood and lungs, which Linné used for his classes.

THE BEGINNINGS OF SYSTEMATIC ZOOLOGY

Systematic zoology is a vast subject, and any address devoted to it must necessarily be very partial. It need only be partial for such an assemblage of masters in zoology as I have the great honor to address, and I shall confine the present discourse to a review of some of the elements which have made systematic zoology what it now is. I will venture, too, to submit reasons why we may have to take a somewhat different view of the achievements of some men than did our early predecessors. If in doing so I may appear to be dogmatic, I entreat you in advance to insert all the "ifs" and "I thinks" and "perhaps" that you may deem to be necessary. For the present purpose, the work of two who exercised, each for a considerable time, a paramount influence on opinion and procedure, deserves notice, especially because

¹ Lankester, Edwin, "The Correspondence of John Ray," 1848, p. 485.

² "Synopsis Methodica Animalium Quadrupedum et Serpentini Generis," 1693, p. 53.

there has been much misapprehension respecting their benefits to natural science. The two were Carl Linné and Georges Cuvier; the one exercised dictatorship from the middle of the eighteenth century till some time after its close; the other was almost equally dominant from the first quarter of the last century to well into the third quarter. No other men approached either of these two in influence on the work of contemporaries or successors. The evil features, as well as the good, were transmitted to and adopted by later authors. Therefore, a notice of those features may help us to a correct judgment of the history of our subject, and may help to show why the disciples of the great Swede, as well as the great Frenchman, complicated many problems they investigated. Sufficient time has elapsed to enable us to judge knowingly and impartially.

CARL LINNÉ

Linné needs no eulogy this year, for his praises have resounded over the whole world. Born just two centuries ago (1707), he published the first edition of the "*Systema Naturae*" in 1735, and his last (twelfth) in 1766. The various editions mark to some extent the steps of man's progress in the knowledge of nature during the time limited by the respective dates.

Linné's industry was great, his sympathies wide-spread, and his method in large part good. Compare the "*Systema Naturae*" and other publications of Linné with works published by earlier authors, and the reason for the active appreciation and esteem which greeted his work will be obvious. The typographical dress and the clearness of expression left no doubt as to what the author meant, and enabled the student to readily grasp his intentions. His boldness in giving expression to new ideas insured success when they deserved

it. Although Ray had already recognized four of the great groups or classes of vertebrates, he had not named them and there were vernacular terms only for the birds and fishes. Linné, for the first time, applied names to the other groups, and admirable ones they were. Mammalia and Amphibia were the coinage of Linné and are still retained; Mammalia or mammals by all; Amphibia or amphibians by the majority for one of the classes now adopted.

A great advance, too—an inspiration of genius, indeed—was the segregation of the animals combined under the class of mammals. Popular prejudice was long universal and is still largely against the idea involved. Sacred writ and classical poetry were against it. It seemed quite unnatural to separate aquatic whales from the fishes which they resembled so much in form and associate them with terrestrial hairy quadrupeds. How difficult it was to accustom one's self to the idea is hard for naturalists of the present day to appreciate. Linné himself was not reconciled to the idea till 1758, although Ray had more than hinted at it more than three-score years before. At last, however, in no uncertain terms, he promulgated it. It was a triumph of science over popular impressions; of anatomical consideration over superficial views.

But mingled with the great benefactions were many views which long influenced naturalists, but which modern zoology has overthrown.

LINNÆAN CLASSES

After the tentative arrangements published in the original first, second and sixth editions of the "Systema," Linné thoroughly revised his work, and first consistently applied the binomial method of nomenclature to all species in the tenth edition, published in 1758. Six classes were ad-

mitted with equal rank, no category being recognized between the class and kingdom. The classes were the Mammalia or Mammals, Aves or Birds, Amphibia, Pisces, Insecta and Vermes. The first four of these classes mainly correspond with the Aves and nameless groups of Ray.

During the Linnaean period of activity the invertebrates were little understood, and his treatment of that enormous host, referred to his two classes Insecta and Vermes, contrasts rather than compares with that at the present time. Naturally, the vertebrates were much better comprehended, and all such then known, with a single exception, were distributed among four classes just named, the Mammalia, Aves, Amphibia and Pisces. The solitary exception of exclusion of a true vertebrate from its fellows was the reference of the genus *Myxine* to the Vermes, next to *Teredo*, the ship-worm. The first two classes were adopted with the same limits they now have, but the Amphibia and Pisces were constituted in a truly remarkable manner. The class of Amphibia was a creation of Linné, and was simply contrasted with his Pisces by having a lung of some kind ("pulmone arbitrario"), while the Pisces have exposed branchiæ ("branchiis externis"). The Amphibia, thus defined, were made to include as orders: (1) Reptiles or Reptilia, having feet; (2) Serpentes, footless, and (3) Nantes, having fins.

Under the Nantes were first grouped the lampreys, the selachians, the anglers (*Lophius*), and the sturgeons (*Acipenser*). In the twelfth edition were added *Cyclopterus*, *Balistes*, *Ostracion*, *Tetraodon*, *Diodon*, *Centriscus*, *Syngnathus* and *Pegasus*. The Nantes were added to the Amphibia partly because of the assumption that the branchial pouches of the lampreys and the selachians were lungs and partly on the authority of Dr. Alexander Garden,

of Charleston, S. C., who mistook the peculiar transversely expanded and partly double air-bladder of *Diodon* for a lung. With such errors of observation as a basis, Linné apparently assumed that all the associated genera also had lungs. Gmelin, in his edition of the "Systema Naturæ" (generally called the thirteenth), corrected this error, and returned all the Nantes to the class of Pisces, thus reverting to the older view of Linné himself. The Pisces of Linné included only the genera left after the exclusion of those just named and also of *Myxine*, which last was referred to the class of Vermes between the leeches (*Hirudo*) and the ship-worms (*Teredo*).

LINNÆAN GENERA

The genera of Linné were intended and thought by him to be natural;³ and natural groups some of the so-called genera were, but present opinion assigns to most of them a very different valuation from that given in the "Systema Naturæ." Some of the genera of invertebrates were extremely comprehensive. For example, *Asterias* included all the members of the modern classes of Stelleroidea or Asteroidea and Ophiuroidea; *Echinus* was coequal with the Echinoidea; *Cancer*, *Scorpio*, *Aranea*, *Scolopendra* and *Julus* were essentially coextensive with orders or even higher groups of the zoologists of the present time. Others were so heterogeneous that they can not be compared with modern groups. Thus *Holothuria*, in the last edition of the "Systema," was made to include four holothurians in the modern sense, a worm, a Physaliid, and three tunicates; in other terms, the so-called genus included representatives of four different classes, and even branches of the animal kingdom.

It has been stated by various writers that the genera of Linné were essentially

³ *Classis et ordo est sapientiae, genus et species Naturæ opus.*—Linn. "Syst. Nat." I., 13.

coequal with the families of modern authors, but, as has been indicated, such is by no means the case. Other striking exceptions to the generalization may be shown.

Not a few of the genera of Vertebrates, although not of the superlative rank as several of the Invertebrates, were equivalent to orders of modern zoology; such were, in the main, *Simia*, *Testudo*, *Vespertilio* and *Rana*. *Simia* included all the anthropoid Primates or monkeys except man; *Vespertilio* was equivalent to the order *Chiroptera* less the genus *Noctilio*; *Testudo* was exactly equal to the order Testudinata or Chelonia; *Rana* to the order Salientia or Anura. A number of other genera of one or few species known to Linné were also of ordinal or subordinal value.

In striking contrast with the range of variation of such genera were others, of which several, well represented in northern waters, may be taken as examples. *Scorpaena* was distinguished simply because it had skinny tags on the head;⁴ *Labrus* because it had free membranous extensions behind the dorsal spines;⁵ and *Cobitis* because it had the caudal peduncle of regular height⁶ and scarcely constricted as usual in fishes. These characters are of such slight systematic importance that they have not been used in the diagnoses of the genera by modern ichthyologists. Further, use of them misled even Linné as well as his successors. Some of the consequences may be noticed.

The close affinity of the "Norway haddock" or Swedish Kungs-fisk or Rödfisk (*Sebastes marinus*) to the typical *Scorpaena* was unperceived and that species

⁴ *Scorpaena. Caput cirris adspersum.*

⁵ *Labrus. Pinna dorsalis ramento post spinas notata.*

⁶ *Cobitis. Corpus vix ad caudam angustatum.*

referred to *Perca* and even confounded with a *Serranus*.

The typical *Labri* of the northern seas do, indeed, have filiform processes of the fin membrane behind the dorsal spines, but most of the species referred by Linné to *Labrus* do not, and among them is a common sunfish (*auritus* = *Lepomis auritus*) of America.

The genus *Cobitis* was made to include Cyprinodonts of the genera *Anableps* and *Fundulus*, and thus were associated fishes differentiated from the Loaches by characters of immeasurably more importance than the trivial one which was the cause of their juxtaposition.

Another conspicuous instance of a trivial character used as generic, and contrasting with very important differentials of species included under the same genus, is furnished by *Esox*. The essential Linnaean diagnostic character is the protrusion of the lower jaw.⁷ Nine species were referred to the genus which represent no less than eight distinct and, mostly, widely separated families of modern systematists.⁸ Several of the species do not have the prominent lower jaw, and one of them (*Lepisosteus osseus* of modern ichthyology) is especially distinguished by Linné himself on account of the shorter lower jaw.⁹

But the most marked cases of insignificance of characters used to differentiate by the side of those serving for combination are found in the class Amphibia.

The genus *Lacerta* is made to include all but one of the pedate Lizards and the Crocodilians as well as the salamanders,

⁷ *Esox*. *Mandibula inferior longior, punctata*. S. N., '58; '66, 424.

⁸ The species are (1) *Sphyraena* (*Sphyraenidae*), (2) *osseus* (*Lepisosteidae*), (3) *Vulpes* (*Albulidae*), (4) *Synodus* (*Synodontidae*), (5) *lucius* (*Luciidae*), (6) *belone* (*Esocidae*), (7) *hepsetus* and (8) *brasiliensis* (*Exocoetidae*), and (9) *gymnocephalus* (*Chirocentridae*). S. N., '66, 513-517.

⁹ *Mandibula inferior brevior*. S. N., '66, 516.

but the "dragons," or Agamoid lizards with expansible ribs, are set apart in an independent genus.¹⁰

The genus *Coluber* was intended to embrace all the snakes, except those with a rattle or undivided abdominal and caudal scutes,¹¹ and hence the vipers and copperheads, so very closely related to the rattlesnakes, were combined with ordinary snakes instead of with their true relations.¹²

Many of the genera of Linné, in fact, were very incongruous, and the great Swede not infrequently failed to interpret and apply their characters in the allocation of species. A few cases furnished by common European or American fishes will illustrate what is meant.

Specimens of the common gunnell or butterfish were received by Linné at different times and once referred to his genus *Ophidion* and at another time to the genus *Blennius*, and the same species stands under both names in the last two editions of his "Systema."

The common toadfish of the Americans (*Opsanus tau*) was placed in the genus *Gadus* (*tau*) and a nearly related species of the Indian Ocean was referred to the genus *Cottus* (*grunniens*).

The common ten-pounder of the American coast served as the type and only species of the genus *Elops*, and also as a second species of the genus *Argentina*, although the characters given were in decided discord with those used for the latter

¹⁰ *Lacerta*. "Corpus (Testa Alisve) nudum, caudatum" contrasting with *Draco*. "Corpus Alis volatile." S. N., '66, 349.

¹¹ *Coluber*. "Scuta abdominalia; squamæ caudales" contrasting with "*Crotalus*. Scuta abdominalia caudaliaque cum crepitaculo" and "*Boa*. Scuta abdominalia caudaliaque absque crepitaculo." S. N., '66, 349.

¹² As an example of *Coluber* a figure (tab. 3, fig. 2) of a snake with venom fangs is given.

genus, and in perfect harmony with those employed for the distinction of the former genus. Indeed, it might be properly assumed that the ascription of the *Argentina carolina* to *Argentina* was simply a matter of misplacement of a manuscript leaf, and such it may be even now considered, although the error is continued in the twelfth edition, having escaped the notice of Linné.

LINNÆAN NOMENCLATURE

The code of nomenclature devised by Linné was in many respects admirable, but he did not provide sufficiently for the principle of priority in nomenclature. He set the example of changing a name given by himself or by others, when he thought a better one could be substituted; he also felt at liberty to change the intent of a genus. A few examples of many cases may illustrate.

In 1756 the name *Salacia* was given to the Portuguese man-of-war; in 1758 the name *Holothuria* was substituted; in 1766 the latter name was retained, but with a very different diagnosis, and for the first time three holothurians in the modern sense of the word were introduced.

In 1756 the names *Cenchrus* and *Crotalophorus* were used for genera, two years later renamed *Boa* and *Crotalus*. In 1756 Artedi's name, *Catodon*, was retained for the sperm whale, and Artedi's *Physeter* mainly for the killers (*Orca*); but in 1758 *Physeter* was taken up for the sperm whale, for which it has been retained ever since, except by a very few naturalists.

In 1756 and 1758 *Ophidion* was used for an acanthopterygian jugular fish—the common northern butterfish, or gunnell, now generally called *Pholis*—but in 1766, under the guise of *Ophidium*, it was transferred to the Apodes and primarily used

for what is still known as the genus *Ophidium*.

In 1756 and 1758 *Trichechus* was used for the manatee alone, while the walrus was correctly associated with the seals, but in 1766 the very retrograde step was taken of associating the walrus with the manatee and retaining for the two the name *Trichechus*. Many naturalists persist to the present day in keeping the name for the walrus alone.

The example thus set by the master was naturally followed by his disciples. Many felt at liberty to change names and range of genera as they thought best and great confusion resulted, which has continued more or less down to this year of grace, 1907.

Many of the evils which have been the consequence could have been rectified if the British Association for the Advancement of Science had been logical in the code (often admirable) which it published in 1842. Instead, however, of accepting the edition of the "Systema Naturæ" (tenth) in which Linné first introduced the binomial nomenclature as the starting point, they preferred homage to an individual rather than truth to a principle, and insisted on the twelfth edition as the initial volume of zoological nomenclature. The unfortunate consequences have been manifold. Such consequences are the natural outcome of illogical and ill-considered action and must always sooner or later follow. After these many years almost all naturalists have acceded to the adoption of the tenth edition.

If the vertebrates were so much misunderstood by Linné, it may naturally be supposed that the invertebrates were equally or still less understood. Only one interesting case, however, can be referred to. In the ninth edition of the "Systema Naturæ" Linné had a monotypic genus

Salacia (p. 79) with a species named *Physalis* which was evidently a *Physalia* as long understood. In the tenth edition the name *Holothuria* was substituted for *Salacia* and no holothurians in the modern sense were recognized. In the twelfth edition all the species of the former edition were retained, but the diagnosis was altered and four holothurians of recent authors were added, and thus animals of different subkingdoms or branches were confounded in the genus. Now, if we accept the tenth edition of the "Systema" as the starting of our nomenclature, obviously *Holothuria* can not be used as it has been for these many years, and it must be revived in place of *Physalia*, notwithstanding the laments of those who are distressed by such a change. The echinoderms now called holothurians must be renamed. We can imagine the clamor that will arise when some one attempts the change.

Another fault of less moment—indeed a matter of taste chiefly—was committed by Linné. Very numerous names of plants and animals occur in the writings of various ancient authors and were mostly unidentifiable in the time of Linné. He drew upon this store with utter disregard of the consequences for names of new genera. Most of the ancient names can now be identified and associated with the species to which they were of old applied, and the incongruity of the old and new usage is striking. For example, *Dasypus*, a Greek name of the hare, was perverted to the armadillos; *Trochilus*, a name of an Egyptian plover, was misused for the humming birds; *Amia*, a name for a tunny, was transferred to the bowfin of North America. There was not the slightest justification for such perversion of the names in analogy or fitness of any kind; there was no real excuse for it. At

the commencement of Linné's career (1737), the learned Professor Dillenius, of Oxford, strongly protested against such misusage for plant genera, but the sinner persisted in the practise till the end. Naturally his scholars and later nomenclators followed the bad example, and systematic zoology is consequently burdened with an immense number of the grossest and most misleading misapplications of ancient names revolting to the classicist and historian alike.

The influence of Linné continued to be felt and his system to be adopted until a new century had for sometime run its course. Meanwhile, in France, a great zoologist was developing a new system which was published at length in 1817, and anew with many modifications a dozen years later (1829).

GEORGES LÉOPOLD CHRÉTIEN FRÉDÉRIC DAGOBERT CUVIER

Georges Cuvier (born 1769) claimed¹³ that before him naturalists distributed all the invertebrates among two classes as by Linné. In 1795 he published an account of memorable anatomical investigations of the invertebrates and ranged them all under six classes: molluses, crustaceans, insects, worms, echinoderms and zoophytes. This was certainly a great improvement over previous systematic efforts, but from our standpoint crude in many respects. It was, however, necessarily crude, for naturalists had to learn how to look as well as to think.

Cuvier later essayed to do for the animal kingdom alone what Linné did for all the kingdoms of nature. So greatly had the number of known animals increased, however, that he did not attempt to give diagnoses of the species, but merely named them, mostly in foot-notes. His superior knowledge of anatomy enabled him to in-

¹³ "Règne Animal," 1817, I., 61.

stitute great improvements in the system. He also first recognized the desirability of combining in major groups classes concerning which a number of general propositions could be postulated.

It was in 1812 that Cuvier presented to the Academy of Sciences¹⁴ his celebrated memoir on a new association of the classes of the animal kingdom, proposing a special category which he called branch (embranchement), and marshaling the classes recognized by him under four primary groups: (1) the Vertebrates or *Animaux vertébrés*; (2) the Mollusks or *Animaux mollusques*; (3) the Articulates or *Animaux articulés*, and (4) the Radiates or *Animaux rayonnés*. These were adopted in the "Régne Animal." In the first (1817) edition, as in the second (1829-1830), nineteen classes were recognized, and in the latter too little consideration was given to the numerous propositions for the improvement of the system that had been suggested and urged meanwhile.

It has been generally assumed that Cuvier's work was fully up to the high mark of the times of publication, and for many years the classification which he gave was accepted by the majority of naturalists as the standard of right. To such extent was this the case that his classification of fishes and the families then defined was retained to at least the penultimate decade of the last century by the first ichthyologists of France. Nevertheless the work was quite backward in some respects and exercised a retardative influence in that the preeminent regard in which the great Frenchman was held and the proclivity to follow a leader kept many from paying any attention to superior work emanating from Cuvier's contemporaries.

It is by no means always the naturalist

¹⁴ *Ann. Museum Nat. Hist.*, Paris, 1812, 19, 73-84.

who enjoys the greatest reputation for the time being that anticipates future conclusions. A Frenchman who held a small place in the world's regard in comparison with Cuvier advanced far ahead of him in certain ideas. Henri Marie Ducrotay de Blainville was the man. When Cuvier (1817) associated the marsupials in the same order as the true carnivores and the monotremes with the edentates, Blainville (1816) contrasted the marsupials and monotremes as *Implacentals* ("Didelphes") against the ordinary *Placentals* ("Monodelphes"). While later (1829) Cuvier still approximated the marsupials to the carnivores, but in a distinct order between the carnivores and the rodents, and still retained the monotremes as a tribe of the edentates, Blainville (1834) recognized the marsupials and monotremes as distinct sublasses of mammals and had proposed the names *Monodelphes*, *Didelphes* and *Ornithodelphes*, still largely used by the most advanced of modern therologists.

Against the action of Cuvier in ranging all the hooved mammals in two orders, the pachyderms (including the elephants) and the ruminants, may be cited the philosophical ideas of Blainville (1816), who combined the same in two very different orders, the *Ongulogrades* and the *Gravigrades* (elephants), and distributed the normal *Ongulogrades* under two groups, those with unpaired hoofs (*Imparidigitates*) and those with paired hoofs (*Pardigitates*), thus anticipating the classification of Owen and recent naturalists by very many years.

Cuvier's treatment of the amphibia of Linné equally contrasted with Blainville's. As late as 1829 the great French naturalist still treated the batrachians as a mere order of reptiles of a single family, and the crocodilians as a simple family of

Saurians. On the other hand, as early as 1816 Blainville had given subclass rank to the naked amphibians with four orders, and also ordinal rank to the crocodilians, and a little later (1822) he raised the subclasses to class rank. Still more, Blainville early (1816) recognized that the so-called naked serpents were true amphibians and gave satisfactory reasons for his assumption, though to the last Cuvier (1829) considered them to be merely a family of the ophidians. As Blainville claimed, he based his classification on anatomical facts.¹⁵

A pupil of Blainville, Ferdinand L'Herminier of the island of Gaudeloupe, at the instance and following the lead of his master (1827), undertook the comparative study of the sternal apparatus of birds and thereby discovered a key to the natural relationship of many types which anticipated by many years the views now current. For instance, L'Herminier first correctly appreciated the differences of the ostriches and penguins from other birds, the difference between the passerines and swifts, the homogeneity of the former, and the affinity of the humming birds and the swifts. Meanwhile Cuvier, like Linné, was content to accept as the basis for his primary classification of birds, superficial modifications of the bill and feet (toes and nails) which led to many unnatural associations as well as separations, but which nevertheless have been persisted in even to our own day by many ornithologists.

Now what could have been the underlying idea which hindered the foremost comparative anatomist of his age from the recognition of what are now considered to be elementary truths and what enabled Blainville to forge so far ahead? Cuvier

¹⁵ "Ses bases sont anatomiques et surtout tirées de la considération du crâne," *Bull. Sc. Soc. Philom.*, 1816, p. 111.

manifestly allowed himself to be influenced by the sentiment prevalent in his time, that systematic zoology and comparative anatomy were different provinces. It may, indeed, seem strange to make the charge against the preeminent anatomist, that he failed because he neglected anatomy, but it must become evident to all who carefully analyze his zoological works that such neglect was his prime fault. He, in fact, treated zoology and anatomy as distinct disciplines, or, in other words, he acted on the principle that animals should be considered independently from two points of view, the superficial, or those facts easily observed, and the deep-seated, or anatomical characters. Blainville, on the contrary, almost from the first, considered animals in their entirety and would estimate their relations by a view of the entire organization. Yet the sentiment then prevalent was reflected by one who enjoyed a high reputation for a time as a "philosophical zoologist"—William Swainson. In "A Treatise on the Geography and Classification of Animals" (1836, p. 173), the author complained that "Cuvier rested his distinctions . . . upon characters which, however good, are not always comprehensible, except to the anatomist. The utility of his system, for general use, is consequently much diminished, and it gives the student an impression (certainly an erroneous one) that the internal, and not the external, structure of an animal alone decides its place in nature." It was long before such a mischievous opinion was discarded.

Cuvier was regarded almost universally by his contemporaries, and long afterwards, in the words of his intellectual successor, Louis Agassiz, as "the greatest zoologist of all time."¹⁶ In view of the facts already cited and innumerable others

¹⁶ Agassiz, "Essay on Classification," p. 286.

that could be added, however, the contemporary verdict must be somewhat modified. Cuvier was a very great man of most impressive personality, wide versatility, extraordinary industry, vast knowledge of zoological and anatomical details, an excellent historian, a useful critic, and of good judgment in affairs generally, but although a greater all-round man, as a systematic zoologist he was not the equal of a couple of his French contemporaries, Blainville or Latreille. We have either to admit this conclusion or confess that our now universally admitted views are wrong. Nevertheless, Cuvier's work was of great importance, and he first brought to the aid of systematic zoology the new science of vertebrate paleontology.

CUVIER AND PALEONTOLOGY

The animals, and especially the vertebrates, of past ages were practically unknown to the early zoologists, and when they had large collections, as did Volta of the fishes of Mount Bolca, they identified them with modern species, or, with Scheuchzer, might consider a giant salamander as a man witness of the deluge—"Homo diluvii testis"! It was not until Cuvier, with superior knowledge of skeletal details, examined numerous bones unearthed from the Tertiary beds about Paris, that the complete distinction of animals of ancient formations from living species was recognized. Then was afforded the first glimpse of extinct faunas destined to far outnumber the existing one, but so imperfect was the great paleontologist's foresight of what lay in store for the future that he enunciated a dogma which was long accepted as sacrosanct; he called it the law of correlation of structure. A striking and even amusing example of its exposition and its failure I have previously drawn attention to.

Professor Huxley, in his excellent "Introduction to the Classification of Animals" (published in 1869), in his first chapter, "On Classification in General," concluded a consideration of Cuvier's law of the correlation of structure with the following paragraphs:

Cuvier, the more servile of whose imitators are fond of citing his mistaken doctrines as to the nature of the methods of paleontology against the conclusions of logic and of common sense, has put this so strongly that I can not refrain from quoting his words.¹⁷

But I doubt if any one would have divined, if untaught by observation, that all ruminants have the foot cleft, and that they alone have it. I doubt if any one would have divined that there are frontal horns only in this class; that those among them which have sharp canines for the most part lack horns.

However, since these relations are constant, they must have some sufficient cause; but since we are ignorant of it, we must make good the defect of the theory by means of observation; it enables us to establish empirical laws, which become almost as certain as rational laws, when they rest on sufficiently repeated observations; so that now, whoso sees merely the print of a cleft foot may conclude that the animal which left this impression ruminated, and this conclusion is as certain as any other in physics or morals. This footprint alone, then, yields to him who observes it, the form of the teeth, the form of the jaws, the form of the vertebrae, the form of all the bones of the legs, of the thighs, of the shoulders, and of the pelvis of the animal which has passed by; it is a surer mark than all those of Zadig.

The first perusal of these remarks would occasion surprise to some and immediately induce a second, more careful reading to ascertain whether they had not been misunderstood. Men much inferior in capacity to Cuvier or Huxley may at once recall living exceptions to the positive statements as to the coordination of the "foot cleft" with the other characteristics specified. One of the most common of domesticated animals—the hog—may come up before the "mind's eye," if not the

¹⁷ "Ossemens fossiles," ed. 4me, tome 1r, p. 184.

actual eye at the moment, to refute any such correlation as was claimed. Nevertheless, notwithstanding the fierce controversial literature centered on Huxley, I have never seen an allusion to the lapse. And yet every one will admit that the hog has the "foot cleft" just as any ruminant, but the "form of the teeth"—and the form of some vertebræ are quite different from those of the ruminants and of course the multiple stomach and adaptation for rumination do not exist in the hog. That any one mammalogist should make such a slip is not very surprising, but that a second equally learned should follow in his steps is a singular psychological curiosity. To make the case clearer to those not well acquainted with mammals, I may add that because the feet are cleft in the same manner in the hogs as in the ruminants, both groups have long been associated in the same order under the name Paridigitates or Artiodactyles, contrasting with another (comprising the tapirs, rhinocerotids and horses) called Imparidigitates and Perissodactyles.

I need scarcely add that the law of correlation applied by Cuvier to the structures of ruminants entirely fails in the case of many extinct mammals discovered since Cuvier's days. Zadig would have been completely nonplussed if he could have seen the imprint of an Agriochœrid, a Uintatheriid, a Menodontid or a Chalicotheriid.

The value of this law was long insisted upon by many. Some of the best anatomists, as Blainville, protested against its universality, but one who ranked with Cuvier in skill and knowledge of anatomy, Richard Owen, long upheld Cuvier's view. "You may not be aware," he wrote in 1843, "that Mr. DeBlainville contends that the ground—viz., a single bone or articular facet of a bone—on which Cuvier deemed it possible to reconstruct the entire animal,

is inadequate to that end. . . . In this opinion I do not coincide."¹⁸ The many mistakes Owen made in attempting to apply the principle proves how well Blainville's contrary opinion was justified.

The numberless remains of past animals, rescued from the many formations which the animals themselves distinguished, have entailed constant revisions of systems and clearer comprehension of the development of the animal kingdom. Such revision, too, must continue for many generations yet to come.

CUVIER AND ANATOMY

The failure to sufficiently apply anatomy to systematic zoology was especially exemplified in the treatment of the fishes which absorbed so much of Cuvier's attention in later years. He, as well as his associate, gave accounts of the visceral anatomy and was led—often misled—to conclusions respecting relations by his dissections, but he failed to receive enlightenment by examination of the numerous skeletons he had made. Those skeletons, pregnant with significance for the future, had no meaning for Cuvier; he never learned how to utilize them for the fishes as he did those of the mammals. His colleague and successor, Valenciennes, in the great "*Histoire Naturelle des Poissons*," was equally unappreciative of the importance of comparative osteology for comprehension of the mutual relations of the groups of fishes.

CUVIER'S SUCCESSORS

The same defect in method or logic that characterized Cuvier's work was manifested by his great English successor in range of knowledge of comparative anatomy, Richard Owen. His families, for the most part, were the artificial assemblages brought together by zoologists on account of superficial characters and too often

¹⁸ Owen, *Am. Journ. Sc. and Arts*, XLV., 1843, 185.

without rigorous attention to the applicability of the characters assigned. Much better was the work of the greatest naturalist of all, Johannes Müller, who advanced our knowledge of the systematic relations of all classes of vertebrates as well as invertebrates. But all were unable to free themselves from the incubus of the popular idea that all branchiferous vertebrates formed a unit to be compared with birds and mammals. Several propositions to segregate, as classes, *Amphioxus* and the chondropterygians had been made, and Louis Agassiz deserves the credit of claiming class value for the myzonts or marsipobranchs as well as the selachians. But it was left to Ernst Haeckel, a pupil of Müller, still happily living, to divest himself entirely of ancient prejudices and appreciate the interrelationship of the primary sections of the vertebrate branch. He for the first time (1866) set apart the amphioxids in a group opposed to all other vertebrates, then docked off the marsipobranchs from all the rest, and collected the classes generally recognized in essentially the same manner as is now prevalent. We may differ from Haeckel as to his classes of fishes and dipnoans, but his correctness in the action just noticed will be conceded by most, if not all, systematic zoologists to-day.

EMBRYOLOGY

While Cuvier was still flourishing, a school of investigators into the developmental changes of the individual in different classes, and among them the vertebrates, was accumulating new material which should be of use to the systematic zoologist. Chief of these was Karl Ernst von Baer. In various memoirs (1826 et seq.) he subjected the major classification of animals to a critical review from an embryological point of view, recognizing, with Cuvier, the existence of four distinct plans which he called types and charac-

terized them in embryological terms—*Evolutio radiata*, *Evolutio contorta* (molluscs), *Evolutio gemina* (articulates) and *Evolutio bigemina* (vertebrates). The last were successively differentiated on account of the embryonic changes from the fishes to the mammals. "These Beiträge," Louis Agassiz justly affirmed, "and the papers in which Cuvier characterized for the first time the four great types of the animal kingdom, are among the most important contributions to general zoology ever published."

One of the most notable results, so far as systematic zoology was involved, was the deduction forced on Kowalevsky by his investigation of the embryology of tunicates, that those animals, long associated with acephalous mollusks, were really degenerate and specialized protovertebrates. This view early won general acceptance.

While embryology was very successfully used for the elucidation of systematic zoology its facts were often misunderstood and perverted. For instance, the cetaceans were regarded as low because they had a primitive fish-like form, although it must be obvious to all logical zoologists of the present time that they are derived from a quadruped stock; snakes have been also regarded as inferior in the scale because no legs were developed, although it would be now conceded by every instructed herpetologist that they are descendants of footed or lizard-like reptiles. *Ammocætes* was considered as higher than *Petromyzon* "inasmuch as the division of the lips indicates a tendency towards a formation of a distinct upper and lower jaw," but we now know that *Ammocætes* is the larval form of *Petromyzon*. Innumerable still more pertinent examples might be adduced for the inferior systematic grades, orders, families, genera, species, etc. The words high and low were used when generalized

and specialized were really meant and those words, pregnant with mischief, often led their users astray as well as the students to which they were addressed.

PHILOSOPHICAL ZOOLOGY

As knowledge of the various animal groups increased and countless new species were piling up, yearning arose to discover principles underlying the enormous mass of accumulating details, and the excoitations of various naturalists resulted in some curious speculation and expression in classificatory form. They called their outpourings philosophy or philosophical zoology, and philosophers they were called by others.

Some of the philosophers grouped animals according to supposed degrees of nervous sensibility;¹⁹ some according to the relations of parts to a center or an axis;²⁰ some under groups supposed to correspond with different systems of the body, as the alimentary, the vascular, the respiratory, the skeletal and the muscular,²¹ and some would accord to each of the senses definite groups.²²

¹⁹ Lamarck (1812) contended for three categories of animals: (1) apathetic animals and (2) sensitive animals among the invertebrates, and (3) intelligent animals, equivalent to the vertebrates.

²⁰ Blainville (1816) proposed to divide the animal kingdom into three subkingdoms: (1) the Artiomorphes, having a bilateral form, (2) the Actinomorphes, having a radiate form, and (3) the Héteromorphes (mainly sponges and protozoans), having an irregular form.

²¹ Oken (1802-47) gave expression to his varying views in several differing classifications. In one scheme (*El. Physiophilosophy*, 1847, 511 et seq.) he claimed that there were five "circles" corresponding with the "animal systems": (1) Intestinal animals (Protozoa and Radiates); (2) Vascular, sexual animals (Mollusks); (3) Respiratory, cutaneous animals (Articulates); (4) Sarcose animals (Vertebrates except mammals), and (5) Aistheseozoa, or animals "with all . . . organs of sense perfectly developed" (mammals).

²² Oken maintained (1802-47): "that the animal classes are virtually nothing else than a rep-

Equally, if not more extravagant, views were entertained by many naturalists that creative power delighted in the symmetry of numbers and in circular arrangements. It was contended that all groups of animals represented analogous groups in successively diminishing circles; that in a perfect system there were a definite number of subkingdoms, an equal number of classes in each subkingdom, of orders in each class of suborders, of families, of genera, of subgenera, etc. Some maintained that three was the regnant number, others upheld four, others seven, but the most numerous and influential school contended for five. Exactly what the philosophers thought they meant, or what strange visions they may have conjured up may never be known. But for a time (1822-42) the school of quinarians, as they were called, claimed most of the naturalists of Britain. The most zealous of the school (William Swainson) was especially displeased with the developmental hypothesis of Lamarck and characterized the "speculations" of the great Frenchman "not merely as fanciful, but absolutely absurd."

But it was the much-contemned hypothesis of descent with modifications that was destined at last to relieve biological science of the wild and irrational speculations and resentation of the sense-organs, and that they must be arranged in accordance with them. Thus, strictly speaking, there are only five animal classes: Dermatozoa (skin or touch animals), or the Invertebrata; Glossozoa (tongue animals), or the fishes . . .; Rhinozoa (nose animals), or the reptiles . . .; Otozoa (ear animals), or the birds; Ophthalmozoa (eye animals), or the Thricozoa (mammals). . . . But since all vegetative systems are subordinate to the tegument or general sense of feeling, the Dermatozoa divide into just as many or corresponding divisions, which on account of the quantity of their contents, may be for the sake of convenience also termed classes." —Oken, *El. Physiophilosophy*, 1847, p. xi. For the many other assumptions on similar and divergent lines the reader must refer to the "Elements of Physiophilosophy" (1847).

classifications of the nature-philosophers, physiophilosophers, circularians, quinarians, trinitarians, septenarians, and their like that flourished during the first half of the past century.

DEVELOPMENT THEORY

Although there had been previous indications of belief that transmutation of species might have been a cause for the diversity of animal life, Jean Baptiste Pierre Antoine de Monet de Lamarck (1809) first framed a hypothesis that had a logical basis, although weakened by unproved postulates. In view of those weaknesses, it was easy to bring forth many facts that seemed to militate unanswerably against it, and such were well put forward by Cuvier; as the hypothesis, too, was very unpopular, it was for a long time stifled. In the meanwhile geological and paleontological investigation, comparative morphology, physiology and embryology, as well as systematic zoology, were revealing innumerable facts that pointed all in the same direction and were only explicable collectively by the assumption that they were the result of original community of origin and subsequent deviation by gradual changes from time to time. The facts were at length collocated with extreme skill by Charles Darwin (1859) and a rational explanation of their evolution by means of natural selection made the new development theory acceptable to well-informed naturalists and logical thinkers generally.

SEQUENCE OF GROUPS

It had been almost the universal custom from olden time, as well as during the Linnaean era, to commence the enumeration or catalogues of animals with the forms exhibiting most analogy with man and consequently the highest in the scale of organic nature. As long as species were assumed to be individually created this was

perhaps the most natural course, and at least had the advantage of proceeding from the comparatively known to the almost unknown. A significant and noteworthy exception to this mode of procedure among the old naturalists was afforded by Lamarck (1809 et seq.), the precursor in this respect as well as in recognition of descent, of the modern school.

When it became generally recognized that there had been always a progression and development from antecedent forms, naturally there was a change in the manner of exposition of a series, and the lowest forms were taken as the initial ones and followed by those successively higher in the scale of beings. Even when old prejudices were administered to and the highest animals put first in a work, it was often done in a reversed series; that is, after the supposed natural ascensive series had been determined on, that series was simply reversed in order that the highest should be the first and the lowest the last. Many of our text-books of zoology still have this characteristic, but are being rapidly replaced by those exhibiting the phyletic series.

HISTOLOGY

One of the most noteworthy modifications of systematic zoology was the fruit of histological research. In 1839 Theodor Schwann, incited by the brilliant results of Matthias Jacob Schleiden's researches (1838) in vegetal histology, and at the suggestion of Johannes Müller, undertook investigations which led him to consider that the animal frame was built up from innumerable cells variously modified to form the different systems and organs of which it is composed. Ultimately the animals thus developed were segregated by Ernst Haeckel, and the animal kingdom was limited to them, while the simple unicellular animals which had been already designated as Protozoa were associated with

unicellular plants under the general term Protista. One of the prominent features of this idea was accepted by Thomas Henry Huxley (1874) with, however, the very important modification of retaining the old name Protozoa as the collective name of the animals and taking a suggested name of Haeckel's (Metazoa) for the multicellular animals.

GRADUAL DELIMITATION OF GENERA

As has been already noted, the animal genera of Linné were mostly extremely comprehensive, answering, when natural groups, to families, superfamilies, and even orders or classes of modern naturalists. Such contrast, however, with others of the Linnaean genera, and when this fact became recognized and it was discovered that the large genera embraced types exhibiting many differences in detail, the latter were subdivided; early in the past century, at first owing especially to French and German naturalists, the subdivision of old genera on approximately present lines was commenced and applied at different times to various classes. It is noteworthy that in some instances the authors of the new genera quite abruptly changed their minds regarding the nature of such groups. For example, Lacépède, in 1798, in the closing lecture of his course at the Museum of Natural History, recognized only 51 genera of mammals, but a few months later (in 1799), in a "tableau," admitted and defined 84 genera.

It seems to be generally supposed that there has been an uninterrupted tendency among zoologists to refinement and increase of number of genera to the present time, but such is by no means the case. Half a century ago and more some ornithologists subdivided old genera and made new ones to an extent to which none of the present time is prepared to go. For example, Charles Bonaparte, Prince of Canino, re-

quired eleven genera of gulls to include those now congregated in one. About the same time, some herpetologists were equally radical. Leopold J. F. J. Fitzinger, in 1843, distributed species which are now combined by all in the genus *Anolis* among no less than fifteen genera. The genus *Bufo*, as now understood, was split by some herpetologists into a dozen or more. These are only samples of numberless analogous cases.

THE OLD AND THE NEW

A comparison of systematic zoology at its dawn with that of the present time is rather a contrast of different themes.

The old naturalists believed that all species of animals were created as such by a divine fiat; the modern consider that all animals are derivatives from former ones and that their differences have been acquired during descent and development.

The Linnaeans based their systems on superficial characteristics, and the moderns take into consideration the entire animal.

The early systematists assumed that characters drawn from structures or parts most useful to the animals were the best guides to the relationship of the animals; the latest ones have learned to distrust the evidential value of similarity of structures unaccompanied by similarity of all parts. The former were guided mainly by physiological characters; the latter take morphological ones.

The Linnaeans confined their generalizations to few categories—genera, orders, classes; the moderns exhibit the manifold modifications and coordinations of all structural parts in many categories—genera, subfamilies, families, superfamilies and various higher groups.

The old naturalists believed more or less in the existence of a regular chain of beings from high to low; the new ones

recognize the boundless ramifications of all animal stocks.

The elders assumed certain forms as highest and ranged their series from high to low; the sons commence their series with the most generalized types and progress from the less generalized to the more specialized.

PROSPECTS AND NEEDS

In numerous old systematic and descriptive works—but in many cases not very old—the skeleton and other anatomical details were noticed in connection with the species described, but not seldom some of those details, if rightly interpreted, would be in contravention of the classification adopted. In fact, the anatomy was to all intents and purposes treated as an offering of curious but useless information. Such conceptions, happily, are mainly—but not entirely—of the past, and we may live to welcome the day when every animal will be treated as whole. Systematic zoology will then be regarded as the expression of our knowledge of the entire structure and as an attempted equation of the results obtained by investigations of all kinds. In fact, systematic zoology is simply an attempt to estimate the relative importance of all structural details and to correlate them so that their relative values shall become most evident. It is the scientific outcome of all anatomical or morphological knowledge and the aim is to arrange the animal groups in such a manner as to show best their genetic relations and the successive steps of divergence from more or less generalized stocks.

One consummation devoutly to be wished for is general acceptance of a standard for comparison and the use of terms with as nearly equal values as the circumstances admit of. There is a great difference in the use of taxonomic names

for the different classes of the animal kingdom. The difference is especially great between usage for the birds and that for the fishes. For the former class, genera, families and orders are based on characters of a very trivial kind. For example, the family of *Turdidae*, or thrushes, relieved of formal verbiage, has been distinguished from neighboring families solely because the young have spots on the breast, but even this distinction is now known to fail in some instances. Extremely few, if any, of the families of oscine birds are based on characters of a kind which would be regarded as of family value in other classes of vertebrates. On the other hand, many of the families and genera of fishes are made by some excellent authorities to include types separated by striking peculiarities of the skeleton as well as the exterior. The mammals are a class whose treatment has been mostly intermediate between that for the birds and that for the fishes. Its divisions, inferior as well as comprehensive, have been founded on anatomical characters to a greater extent than for any other class. Its students are numerous and qualified. Mammalogy might therefore well be accepted as a standard for taxonomy, and the groups adopted for it be imitated as nearly as the differing conditions will admit. The families of birds would then be much reduced in number and those of fishes increased. All the active herpetologists and ichthyologists of the United States have subordinated their own beliefs and ideas as to what would have been most desirable, to a greater or less extent, to approximate the desirable reduction of the terms admitted by them to a standard uniform with that adopted by mammalogists. If others would likewise sacrifice their own predilections, the lamentable inequality of usage now prevalent would be much less;

such congruity would be to the great advantage of comparative taxonomy.

In these days of extreme specialization one of the greatest needs in our universities is a professor of systematic zoology with whom conference may be held as to the propriety of any systematic modification resulting from special investigation of the anatomy of any organ or part, or of any group of animals. Such conference might prevent the publication of many propositions due to exclusive consideration of an isolated subject. Perhaps the designation of systematic morphology might better indicate the nature of the suggested course. The consummation, however, it must be admitted, is more desirable than probable.

I have intentionally refrained from any consideration of the work of living zoologists. If I had undertaken this, the task of selection would have been very difficult, and at any rate the time demanded for proper consideration would have been much more than that requisite for the remainder of past discoveries. The progress of systematic zoology during recent years has been in accelerated ratio, and not a few of those whose achievements have helped to put zoology at its present level are in Boston to-day. It is from the summit of the elevation they have enabled us to reach that we look back to the deeds of old masters and can determine, better than their contemporaries or immediate successors, their relative merits.

THEO. GILL

SCIENTIFIC BOOKS

Anatomical Terminology with Special Reference to the [BNA]. By PROFESSOR LEWELLYS F. BARKER. Philadelphia, P. Blakiston's Son & Co. 1907.

The necessity for both exactness and simplicity in the nomenclature employed in the descriptive sciences has always been recog-

nized, and in anatomy several attempts have been made to establish a terminology which would be acceptable to the great body of anatomists and eliminate from anatomical nomenclature the ponderous mass of synonyms with which it is burdened. Henle in his classic "Handbook" accomplished much towards the desired end, and since 1880 Professor B. G. Wilder has labored assiduously for the cause. But it was not a matter for accomplishment by a single individual working independently; it required concerted action. And although endeavors had been made to enlist the sympathies of the American Association for the Advancement of Science and the Association of American Anatomists in the work, for one reason or another little definite progress was made.

In 1887 the pressing need of an authoritative revision of anatomical nomenclature was brought to the attention of the German Anatomical Society, then but recently organized, and in 1889 it established a commission to deal with the matter, appointing upon the commission Professors von Kölliker (chairman), O. Hertwig, His, Kollmann, Merkel, Schwalbe, Toldt, Waldeyer and von Bardeleben, Professor Krause being later selected as editor-in-chief and representatives of Great Britain and other countries being also included. For six years the commission labored with the difficulties assigned for its consideration, and in 1895 it presented a report to the society, submitting a list of some 4,500 terms, carefully selected from the 30,000 or more, principally synonyms, which may be collected from the various standard text-books. The society received and adopted the commission's report at its meeting in Basel, a circumstance which has gained for the list the appellation of the Basel Anatomical Nomenclature or, more briefly, the BNA, and the report, drawn up by Professor His, was published as a supplement number of the *Archiv für Anatomie und Physiologie*.

This is neither the time nor the place for a discussion of the work of the commission; suffice it to say that its results have been widely accepted and that a uniformity of an-

atomical nomenclature has by it been brought within easy reach. The original report, however, has not been sufficiently accessible in this country, and Professor Barker has done good service for anatomy in republishing the list of accepted terms in their Latin form as originally adopted, giving also a literal translation of each term; and, in the few cases when a term differs to any great extent from the English usage, the familiar term is also added. The nomenclature is thus made accessible in a convenient form for all who require a knowledge of anatomical terms, and the introduction to the book, in which are given an interesting account of the work of the commission and a discussion of the advantages of a uniform terminology, is worthy of careful perusal by all who are in any way interested in anatomy.

The translations of some of the Latin terms are open to criticism in that convenience has occasionally been sacrificed to literalness; it seems unnecessary, for instance, to translate *intestinum jejunum*, *intestinum ileum* and *intestinum cæcum* by empty intestine, twisted intestine and blind intestine, when the adjectival portions of the Latin terms are already in common use in English text-books. There seems little likelihood that the Latin terms will be generally employed by English-speaking people, nor is it necessary that they should be; their use merely adds an additional burden for the student and savors somewhat of pedantry. It would perhaps be a further aid to the cause of uniform terminology if, let us say, the American Association of Anatomists would select for each BNA term an English form; the great majority of Professor Barker's translations, and they are intended merely as translations, could be adopted as they stand, and, with some few modifications, the entire list given an authority which it now lacks.

J. P. McM.

The Labyrinth of Animals. (Including mammals, birds, reptiles and amphibians.)
By ALBERT A. GRAY, M.D., F.R.S.E., Surgeon for Diseases of the Ear to the Victoria Infirmary, Glasgow. London, J. &

A. Churchill. 1907. Vol. I. Pp. 197; 31 stereoscopic photographs.

This volume deals with the labyrinths of Primates (man, yellow-faced baboon, black ape, green monkey, Hocheur monkey, Mona monkey, common marmoset, mongoose lemur, slow loris); Cheiroptera (Indian fruit bat, pipistrelle); Carnivora (tiger, lion, cat, puma, dog, aard-wolf, mongoose, otter, common weasel, crab-eating raccoon, common seal, gray seal, Cape sea-lion); Ungulata (the beisa antelope, Indian gazelle, common sheep, dromedary, common pig, horse); Edentata (three-toed sloth, Tamanduan ant-eater); and Rodentia (common hare, common rabbit, common mouse, common rat, hairy-footed jerboa). It is intended to bring out a second volume dealing with rodents, insectivora, cetacea, sirenia, marsupalia, monotremata, birds, reptiles and amphibia.

The method of study employed is as follows: The labyrinth with the bone immediately about it is fixed in a five- to ten-per-cent. formaline solution, embedded first in celloidin and then in paraffin, decalcified in hydrochloric acid and then washed. There remains a cast of the organ in paraffin and in this the membranous structures are embedded. The object is now placed in xylol, which removes the paraffin and leaves the organ transparent. It is then photographed from two points of view by taking one picture, then slightly rotating the object-holder and taking the other picture. Each picture represents the image seen by one eye. The pictures are mounted like ordinary stereoscopic photographs and are studied with a stereoscope. In publishing these photographs they are pasted on rather heavy cardboard, two to a page, and the book is accompanied by a pair of prisms, with which, after a little practise, good stereoscopic images may be obtained.

Dr. Gray is evidently a skilled preparator. In the photographs the objects are magnified, usually from four to six diameters, and through the stereoscope they stand out with a beautiful distinctness.

Each photograph is accompanied by a few lines of descriptive text. In addition brief

summaries are given of the chief characteristics of the labyrinth of animals of various species and orders. References are made to the more important papers dealing with the comparative anatomy of the labyrinth. There is no attempt at a prolonged treatment of the speculative aspect of the subject, although there is a short chapter in which there is discussed the value of the labyrinth in the determination of phylogenetic problems. The semicircular canals vary more from species to species than the cochlea does. There are two types of cochlea: sharp pointed, carnivora and rodents; flat; cetacea, primates, ungulata, chiroptera, sirenia, and insectivora. The edentata have an intermediate type. Both types are found in the marsupalia.

At the end of the volume there is given a very important table of the chief measurements of each of the labyrinths studied.

Stereoscopic illustrations of organic structures are likely to be more and more utilized as simpler methods of taking the photographs and of studying them are devised. Dr. Gray has been undoubtedly successful in both respects. There are, however, some disadvantages in relying wholly upon this method of illustration. Only one object can be viewed at a time, so that quick comparison of two or more objects is difficult. The value of the book to one who has not a great deal of time to devote to its perusal would be much increased were diagrammatic outlines of the objects studied arranged in groups. With the more important similarities and differences thus emphasized the details revealed by the stereoscope could be followed with greater ease and interest.

The author has, however, furnished a rich lot of material for the comparative anatomist, and has made a distinct contribution to anatomical technique.

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HERPETOLOGY OF JAPAN AND ADJACENT TERRITORY

"HERPETOLOGY of Japan and Adjacent Territory" forms an important addition to scientific literature and is the work of Dr. Leon-

hard Stejneger, curator of the division of reptiles and batrachians in the United States National Museum. Even a superficial examination of this work shows Dr. Stejneger's painstaking methods in handling his subject. His manner of simplifying descriptions, interspersing paragraphs helpful to the novice, besides giving some attention to habits, produces a work of far broader use and interest than a strictly technical compilation. The author has taken uniform care to present a résumé under the head of each order, sub-order, family and genus, this plan being very satisfactory to the reader in bringing his information strictly up-to-date. The tendency of boiling down descriptions of families and genera to concise and pertinent paragraphs shows considerable study. Strong characteristics are brought to the front and the student is saved wading through the mass of descriptive matter favored by many scientific writers—which matter is often remarkable for its repetition. Throughout the work, there is an effort, by means of foot-notes, to define the meaning of the technical names—both generic and specific—a method we have noted in previous work by Dr. Stejneger. An excellent idea—applied to the treatment of the serpents—is the presence of the popular Japanese name over the description of each species. This condition should make the work very useful to the collector in Japanese territory.

The thirty-five plates show judicious selection. Regarding them the author explains:

The plates are mostly reproductions of important illustrations more or less inaccessible to those for whom this work is chiefly intended. Very often these illustrations represent type specimens, and in nearly every instance are based on specimens collected in the regions covered by this work. The expensive *Fauna Japonica* is long since out of print, and the reproduction of the best figures from this classic will be welcome to the majority of students of Japanese herpetology.

In the text are numerous pen drawings by Mr. R. G. Paine—to the number of over four hundred. Altogether the work may be said to be profusely illustrated and, with its nu-

merous keys, fine bibliography and list of localities in Japan, the Riu Kiu Archipelago and Formosa (with their synonyms) arranged in the form of a consulting and descriptive list, should be of much value to all students of herpetology.

In his enumeration of species Dr. Stejneger shows us that 50 species of amphibians are to be found in Japan and adjacent territory. Of the order *Caudata* (salamanders and newts) there are 13 species. The *Salientia* (order of frogs and toads) is represented by 37 species. Seventeen species of *Rana* (genus of typical frogs) occur in the territory treated. The reptiles are elaborately represented, though the serpents greatly predominate in number of species. The lizards occur to the number of 29 species—these the members of 15 genera. Sixty-one species of snakes are enumerated, representing 26 genera. Among the serpents are 25 poisonous species, which are the members of 13 genera. Among the venomous snakes the members of 6 genera and to the number of 13 species are marine or the inhabitants of bays or the mouths of the larger rivers. The author's treatment of the strictly aquatic snakes—the *Hydrinæ*—is particularly interesting in adding to knowledge relating to the distribution of these reptiles. Of the order of turtles and tortoises 11 genera are quoted and 14 species described as inhabitants of the area involved.

While Dr. Stejneger's work is uniformly valuable to the herpetologist there is a tendency throughout to alter the nomenclature of families and genera. The author explains:

With regard to the nomenclature of families, genera and species, the author adheres strictly to the "International Rules of Zoological Nomenclature" adopted by the International Congresses of Zoology. Changes in nomenclature necessitated by these rules, therefore, must not be laid to any desire of the author to alter names, but to the necessity of conforming strictly to the laws now generally accepted by the working zoologists of the world.

To the writer of this review it seems that the laws mentioned should have some limitation. This search for "priority" by technical students is discouraging many young students

of zoology, who, after mastering various scientific names in works that have supposedly brought them strictly up-to-date, find in subsequent works an imposing array of unfamiliar titles. The adjustment of "priority" appears to be as remotely distant as ever: for with the greater number of scientific works appearing we find suggestions by the authors as to sweeping changes in nomenclature. It seems a pity to batter down names that have for years been generally accepted. Few zoologists are much benefited by perusing exhaustive lists of synonyms and the preparation and study of these must detract from actual observations of the subjects involved.

Among long-standing names that have fallen by Dr. Stejneger's decisions is the term for a great class—the Batrachia. This, the author explains, is a synonym pure and simple of the much older term *Salientia*, standing for the order of frogs and toads. That these changes in nomenclature are difficult to follow is in evidence from the cover of Dr. Stejneger's publication where the author's title is given "Curator, Division of Reptiles and Batrachians," while to be strictly up-to-date and correct, as pointed out in the text, it should be "Curator, Division of Reptiles and Amphibians." Among other changes in nomenclature might be mentioned the well-established genus of snakes *Coluber*—changed to *Elaphe*, and, as an instance that is liable to bring about some confusion, the use of the term *Coluber* in place of *Pelias* among the vipers. Also, according to the author, the family term *Viperidæ* must go. A new name, the *Cobridæ*, is substituted for it. Dr. Stejneger arranges in the family *Elapidæ* the subfamilies *Elapinæ* and *Hydrinæ* (*Hydrophinae*). It appears inconsistent to follow this arrangement with the designation of the *Cobridæ* (*Viperidæ*) and the *Crotalidæ* as distinct families.

To the strictly technical worker these discussions and changes in nomenclature are barely confusing—and may be of considerable interest. They certainly show a great amount of thought and work on the part of the author. To the less advanced student, however, the new terms appear formidable, set former

knowledge at variance and bring about a vague query as to whether it is worth while to adopt any particular system of classification while zoological nomenclature remains liable to such changes. In view, however, of the general excellence of Dr. Stejneger's publication, these criticisms must be classed as quite superficial.

RAYMOND L. DITMARS

THE NEW YORK ZOOLOGICAL PARK

DISCUSSION AND CORRESPONDENCE

A PLAN OF PUBLICATION FOR AGRICULTURAL EXPERIMENT STATION INVESTIGATIONS

THE passage of the Adams Act marked a new era in the development of the agricultural experiment stations and is destined to exercise a great influence on the character of the investigations and the publications issued. The investigations carried on under the Hatch act, while largely scientific, have nevertheless, in the main, been of general character intended primarily to meet the immediate needs of farmers and orchardists.

When the stations were first established as a result of the Hatch Act, agriculture was in a chaotic condition, there being scarcely any available trustworthy literature. The first work of the stations was thus, naturally and properly, largely pioneer work. This work has been carried forward with energy and success and "scientific farming," so called, has been rescued from disrepute and established on a basis of trust and confidence. With the systematizing and advance of our knowledge and the development of a trained corps of scientific agricultural workers, the necessity for more profound research on agricultural problems has become more and more apparent. Station workers, heretofore, have generally been unable to undertake very extensive research on fundamental problems, owing to lack of funds, the demand for immediate information on lesser problems, routine duties in answering correspondence and the multitudinous duties incident to the work of organization and the promotion of agricultural knowledge. With the passage of the Adams Act, which is expected to be used exclusively for fundamental research, the character of the

work will be largely changed and extensive experiments will be carried out on the fundamental problems of agriculture, which will not have in view their immediate practical value. Heretofore the bulletins published in the series of the various stations have been largely of practical nature and adapted to the immediate needs of agriculture. True, very many bulletins have been published containing excellent scientific matter, but these were largely out of place in the regular series of bulletins as maintained by the stations. In several stations scientific and technical series of bulletins were started to accommodate such scientific papers which were not suited for general distribution. Owing to the confusion in quoting such publications and other reasons, all such special series have, I believe, been discontinued.

As a result of the Adams Act there is certain to be many bulletins prepared in the near future of purely scientific nature, which will not be satisfactory for publication in the regular series of station bulletins. It behooves station authorities, therefore, to carefully consider the means of publication and devise some satisfactory method which will meet the present requirements and provide for future needs. The writer has given this matter considerable thought and desires to suggest the plan described below for consideration.

The writer would suggest the establishment of a series of agricultural journals or memoirs to be edited and published under the direction of the Association of Agricultural Colleges and Experiment Stations. The field of agricultural research could be divided up and a separate series maintained for each division, as, for instance, a separate series for each of the following subjects:

Agronomy,
Horticulture,
Plant Pathology,
Plant Physiology and Anatomy,
Plant Biology and Breeding,
Soil Investigation,
Dairy Investigation,
Animal Husbandry,
Poultry Investigation,
Animal-breeding,

Animal Pathology,
Entomological Investigation,
Etc.

As a method of handling such publications an editing committee of three station workers could be appointed by the association for each subject, who would examine, edit and pass on the suitability of papers submitted for publication in the scientific journals. Papers for publication could be forwarded direct to the chairman of the proper committee by the directors of the various stations and in case the committee considered them unsatisfactory for publication in the journal, they could be returned to the director of the station with the recommendation that they be published in his regular series of station bulletins or remodeled to fit them for publication in the journal.

Such journals, if established, the writer believes, should not be distributed free of cost except possibly a single set to the library of each station, and to the Department of Agriculture and the Congressional Library. Aside from these a regular price per volume should be charged for subscription as is done for standard periodicals.

The funds from subscriptions would in considerable measure pay for the expense of publication. Each station should probably pay a certain limited annual stipend for regular maintenance and privilege of participation in the enterprise, and after the above funds are exhausted, any deficit at the end of the year could be assessed against the stations publishing articles during the year, in proportion to the pagination published. In this way the publication could be easily financed and probably at less expense than any station could now publish and distribute similar articles which are sent gratis.

This scheme of publication if put into operation would necessitate the employment of a business manager and assistants and the establishment of a headquarters from which all arrangements for publication and distribution could be made. This office, however, should exercise no function except as related to the business of publication.

Many important reasons can be assigned why some such scheme of publication as the above should be put into operation. The writer assumes that it must be clear to every one that some different source of publication from those now existing in the stations must be provided.

Purely technical papers on the cytology of heredity or on soil bacteriology, for instance, while of the utmost fundamental value might, if published in the regular series of station bulletins, be actually ridiculed and bring a station into disrepute with certain classes of their constituents. In any case such technical papers intended for specialists have no place in our present series of bulletins, which are intended for general distribution, and would be largely lost to the people for whom they are intended, when published in such a place.

It may be argued that the time has now come when each station should publish a separate scientific or technical series of bulletins. I would answer that the scientific publications of any one station will not be sufficient in number to attract special notice and justify the publication of a special series, and even if this were the case it would be a poor place to publish such matter, where all subjects are run together in one series, and considering the number of stations publishing. What all writers and stations desire is to place their good matter where it will receive the most attention and be most easily preserved and found. Every one knows from experience, that the literature which is always preserved and most easily accessible is that found in standard periodicals which are issued in volumes and indexed. If special journals were established for the different important subjects, investigators would know immediately where to look for articles on any particular subject. They could subscribe for and receive regularly the journals representing the subjects in which they are especially interested and would know when they had looked over all of the available experiment-station literature on a given subject. I am something of a plant-breeder, yet I do not

doubt that some rather important matter on breeding has been issued by some of our experiment stations which I have not seen. If, however, we had a journal of plant-breeding in which every breeder in the experiment stations would describe in full or at least in summary his important results, I could soon look over that journal and feel confident of knowing what had been accomplished by the experiment-station workers.

Purely scientific articles could be published, possibly in some of the existing scientific journals, but these will not meet the requirements. The station is given public funds for conducting investigations and it would seem necessary that they have a recognized place of publication. They can not be altogether dependent on private sources of publication. Many articles in any case will find their way to established scientific periodicals and a liberal amount of such publications should, the writer believes, be encouraged. He feels, however, that it is absolutely necessary to have distinctive publications for the stations which will represent their work.

A modification of the above plan which might more nearly meet the views of some persons would be to publish separate bulletins numbered consecutively under each series or subject, *i. e.*, Agronomy Bulletins, 1, 2, 3, etc., or Dairy Industry, 1, 2, 3, etc. Similar to the publications of the Carnegie Institution, except classified under different subjects so that it would not be so difficult to determine what had been published on a given subject. Each bulletin in this case to be sold separately. While there are many points in favor of such separate publication and sale, the writer believes that all things considered, a periodical publication which can be subscribed for by the volume meets more of the requirements. The writer has submitted the substance of this paper to several of his colleagues for criticism and suggestions. In a letter regarding the matter, Director L. H. Bailey states:

I have gone over your proposition for a series of publications and I like it very much. . . . I feel that the series should have unity and solidarity.

Rather than to have the series of journals I think there ought to be one series of memoirs, perhaps broken up into parts representing the different subjects. These parts could be published separately. References then could be made to the memoirs as a whole with a designation as to Botany series, Plant Breeding series, Poultry series, and the like, much as is done at the present time with the *Annales des Sciences*. The assessment against the institutions for such publication could not be made against the Adams Fund, as that can not be used for publication. I suspect that most of the institutions already mortgage their Hatch Fund for publication as heavily as they ought. However, I am sure that some way could be found whereby the money could be secured.

Doctor T. L. Lyon writes as follows:

I have looked over the plan you propose for publishing the technical results obtained by the several experiment stations. This strikes me as an extremely good plan and I see no reason why it could not be put into execution. I should like to make one suggestion that I think might make the plan work a little more smoothly. I notice that you provide for expense of publication by charging for the several publications, and dividing these publications into series based upon the subjects of which they treat. In order that due economy shall be exercised in the publication, the committee in charge of each series should receive annually a sum of money proportional to the amount received in subscriptions, which together with the subscription fees should be available for meeting the expense of publication. An arrangement of this kind will, I think, result in having each series appeal to a sufficient constituency to make its publication worth while. I have given some attention to the arrangement of series that you propose. It seems to me that if there is any improvement to be made in your arrangement it would be in decreasing the number of series. I have thought of the following arrangement:

Plant Production (including investigations in soils, plant nutrition and propagation, atmosphere and water).

Plant Life (including anatomy, composition, physiology and pathology).

Principles of Breeding.

Dairy Investigation.

Animal Production (including improvements by breeding, nutrition, care and management).

Veterinary Science (including anatomy, composition, physiology and pathology).

Entomology.

Engineering.

This reduces the number somewhat and includes one subject not included in your classification. I believe that the time has come when we must have technical journals in subjects pertaining to agriculture just as they have in all other branches of scientific work.

Professor J. W. Gilmore writes:

This scheme seems to me eminently feasible and I believe is a distinct step in arranging and systematizing our station literature. I would like to hear a discussion, however, along three lines at least:

1. Scheme of classification.
2. Whether station workers might not receive any or all of the series free on request.
3. What may be the attitude of the now-established scientific journals toward the scheme.

Would it be well to invite discussion along these lines?

The methods and means of publication for scientific station matter is a subject in which all experiment-station investigators are vitally interested, and the writer has thought it desirable to publish his thoughts on the subject, hoping to stimulate a general discussion out of which sentiment may crystallize so that some advanced step may soon be taken by the station authorities.

H. J. WEBBER

CORNELL UNIVERSITY

ON THE EFFECTS OF MAGNESIUM SULPHATE ON
PLANTS

IN the issue of SCIENCE of August 16, Professor William J. Gies publishes a letter, in which my refutation of an unjust attack is subjected to an analysis which I cannot regard as going to the essential point. I must, therefore, once more and more distinctly state that my inferences as to the *poisonous action of magnesium sulphate* on plants can, of course, only relate to the conditions of my experiments and that *I nowhere have made the assertion that these poisonous actions would be observed also at still higher dilutions than those I had used*, for I was very well acquainted with the truth that the action of a poisonous substance decreases with the dilution and that beyond a certain dilution even a stimulating action can take place.

I have further pointed out that the poisonous effects of that salt are modified by the lime content of the cells; the more lime there is present in the cells, the more magnesium sulphate will be required to exert a poisonous action. From this standpoint my own observation on the stimulating action of magnesium sulphate¹ under certain conditions, becomes intelligible.

OSCAR LOEW

SPECIAL ARTICLES

THE SPARK CHRONOSCOPE

EIGHT years ago I published a description of a new chronoscope in a technical monograph. Eight years of continued use, in which the instrument has been tested for convenience, durability, adaptation and accuracy, give such assurance of satisfaction that I am moved to bring the instrument to the attention of a wider circle of scientists through the columns of this journal. I would especially invite comparison with other instruments on the three fundamental qualities of accuracy, economy in operation and adaptability.

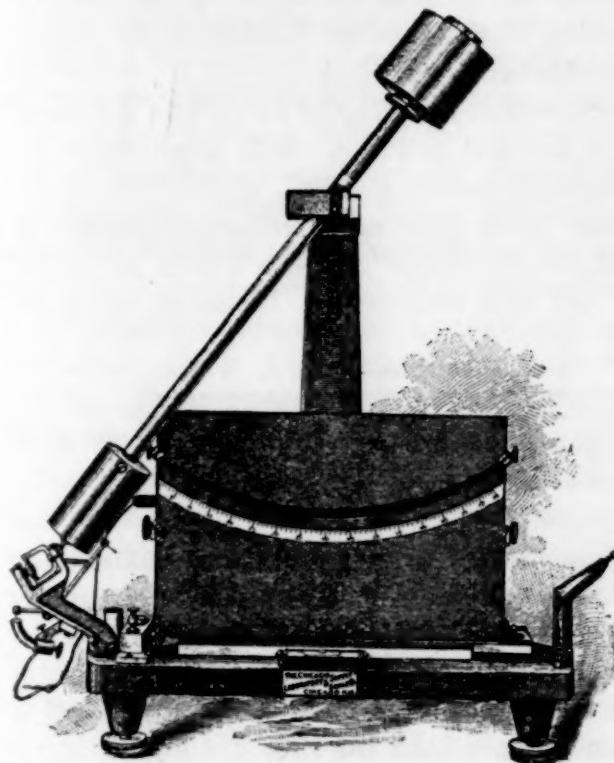
The following brief description is essentially an extract from the original account in *The University of Iowa Studies in Psychology*, Vol. II., p. 155 ff.

Of the hitherto known forms of apparatus for measuring short intervals of time, the graphic spark apparatus is the most accurate and the pendulum apparatus the most convenient. In the chronoscope that is shown in the accompanying figure, the spark method of recording is combined with the pendulum action.

The cut is reduced to a scale one sixth of the size of the apparatus. The pendulum is shown in the starting position. The lower bob terminates in a knife edge which rests upon the projecting edge of a mechanical release key. The action of this key is soundless and gives the pendulum no impetus in either direction. On the other side of the apparatus is a spring key which catches the pendulum at the

¹ Cf. "Flora," 1893; observations on the growth of the roots of *Tradescantia*, in my article on the "Physiological Functions of Lime and Magnesia."

end of the swing. When the pendulum is released from this, it swings back with little assistance to the starting point and makes all necessary adjustments automatically. On the



back of the lower bob is an index point which runs at the upper edge of the scale and serves as a spark point.

The record is made upon a smoked paper which is seen through the slit above the scale. This paper is stretched upon two rollers; it also rests upon an insulated metal plate which serves as an electrode and keeps the paper straight and smooth back of the scale. Back of this plate is a third roller by means of which the tension of the paper may be adjusted. The paper support is built on a carriage so that it may be removed and replaced without disturbing the rest of the apparatus. In preparing the paper this carriage is removed and the paper is smoked as on an ordinary kymograph drum. As a complete record consists in a single spark which may be recorded at once, several hundred records may be made with one preparation of the paper. The paper is moved, as needed, by a thumb screw at one end of the upper roller.

In reaction experiments the stimulus is

given automatically by the apparatus when the pendulum indicator passes the zero point on the scale. A double rocking lever at this point makes one circuit and breaks another, either of which may be used in giving the stimulus. These contacts are adjustable platinum and mercury contacts and their adjustment may be verified by direct sight. The closing or opening of the circuit is soundless, and the stopping of the lever in a soft rubber clutch makes no sound that can be heard a few feet away.

The reaction, or termination of the interval to be measured, is indicated by a spark on the sensitive paper at the edge of the scale. The spark is produced by interrupting the primary circuit of an ordinary induction coil. One secondary terminal is connected with the insulated plate on which the paper rests and the other is connected with the body of the apparatus. The point of the pendulum indicator is the nearest metal to the plate; therefore the spark flies from this point, through the sensitive paper, to the plate.

The scale is graduated empirically by the most reliable graphic method into hundredths of a second, and each unit is divided into halves. The average space of one unit is 5 mm. on the arc of the scale. With this adjustment the scale covers 0.80 sec. and the records are read in half-hundredths with ease and accuracy. This division is the most convenient and appropriate to use in reaction experiments. The variation in the movement of the pendulum is negligible because the pendulum is carefully constructed and balanced and moves without friction. The variation in the make contact is also negligible because the platinum terminal moves much faster than the pendulum indicator. The spark tends to take the shortest course between the point and the plate, but it may be deflected. The maximum distance between the spark point and the paper is 1 mm. The maximum deflection of the spark may be estimated to be about 45° . That amount of deflection is not liable to occur for the maximum distance, but if it did the maximum variation would be ± 1 mm. on the scale, which is equal, on the

average, to ± 0.002 sec. The average distance between the spark point and the paper is about .5 mm. and the average angle of deflection of the spark is less than half of 45° ; therefore the average variation in the spark is less than ± 0.001 sec.

The chronoscope may be adapted for the measurement of longer intervals, as in the study of association, by two minor changes which can be made in a minute. A small weight is fastened on the top of the upper bob. This makes the pendulum swing so slowly that it takes three seconds to cover the arc of the scale. A corresponding scale, graduated empirically in hundredths of a second, is clamped over the regular scale. The accuracy is nearly proportional to the speed of the pendulum.

Similarly, if there should be a demand for finer readings than those obtained by the standard adjustment, an extra weight may be placed on the lower bob that will cause the pendulum to cover the arc of the scale, for example, in one third of a second. If the corresponding scale is graduated in thousandths of a second each unit will occupy, on the average, 1 mm. of space. The degree of accuracy will be nearly proportional to the speed, because the latent time of the spark is negligible and the action is frictionless.

Much of the value of a chronoscope lies in its adaptation to the attachment of a variety of accessories. The possession of the soundless make and break contacts for the stimulus circuit makes it possible to connect all sorts of electric stimulus apparatus, such as the telephone receiver, the touch key, the tachistoscopes, etc.

For regulating time-exposures, a movable pendulum contact is attached to the front of the base and adjusted, by reference to the scale, for any desired length of exposure from a hundredth of a second to three seconds. This contact may be used either as a make or break and the circuit may be completed either through the make or the break of the stimulus contacts.

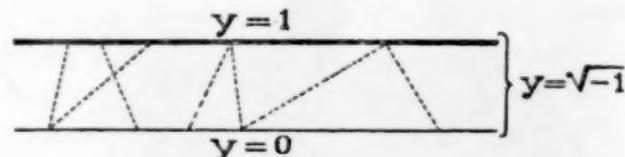
C. E. SEASHORE

THE UNIVERSITY OF IOWA

A VECTOR DIAGRAM

APROPOS of Carl Barus's interesting note in SCIENCE of August 2, p. 149, it may not be amiss to call attention to a representation that I used in a communication to the March meeting of the Chicago Section of the American Mathematical Society.¹

I represent a real point (x', y') in the plane by a dot and call it a black point, while an imaginary point $(x' + ix'', y' + iy'')$ is represented by a blue point coincident with the real point $(x' + x'', y' + y'')$ and joined to (x', y') by a real vector. Where no confusion



is caused the real vector is drawn straight, but otherwise it may be curved, it being understood that the direction is determined by the end points. Furthermore, if the vector moves its end points describe a black curve and a blue curve. Thus the line

$$y = \sqrt{-1}$$

is represented by joining every point in the black line

$$y = 0$$

to every point in the blue line

$$y = 1.$$

In the accompanying diagram the "blue line" is drawn heavy, the "red lines" broken.

ELLERY W. DAVIS

QUOTATIONS

LIVING ON OUR CAPITAL

THE passion to beat our records in material advancement tends to blind the thought to the fact that we are rapidly consuming the very fundamental resources on which the prosperity of the country rests. Without doubt the timber supply of the United States is disappearing far more rapidly than any increment of growth. The treatment of the soil in much

¹ Bulletin of the American Mathematical Society, June, 1907, p. 436.

of the best agricultural lands is still of the kind that exhausts fertility and makes crop failures inevitable.

In the use of the iron ore deposits there is not even the possibility of duplication in preventing the exhaustion of supply. The rate of utilization has for several years been going on at from 25,000,000 to 30,000,000 tons a year. The country has been taking out, say 400,000 tons of copper a year and the coal mines of the country yield 475,000,000 tons. The annual lumber and timber products, including fire and pulp wood, are probably valued at no less than \$1,000,000,000. Excepting agriculture and lumbering, there is no possible way of replenishing supplies once exhausted, except by the discovery of new sources of production.

The forests, the coal beds, the iron ore and the copper, along with the fertility of the soil, are essential parts of the capital of the nation. The annual output from them is not simply income; it is to a large extent a spending of capital. Expenditure of capital resources always points to a time when the community will be put to the necessity of finding substitutes for any one or more of these fundamental elements of national strength. Without attempting to forecast the time of such exhaustion the policy of the present requires that efforts be made in two directions to put off as far as possible the day of reckoning. For the nation that has lost its elements of might in material resources cannot hope to maintain its ascendancy among its more powerful and farseeing competitors.

The two things which a nation can do are to economize consumption and to discover substitutes. The natural effect of rapid consumption is productive of higher prices, which in themselves supply an automatic check. But before the check of advancing prices sets in there are always wasteful methods at work which are themselves to no small extent the cause of advancing prices. Only after billions of dollars have been lost in the treatment of the soil, of the forests and the mines, does the policy of more economical management force itself upon those in control. The natural law of supply and demand compels man in his

treatment of nature to become a better husbandman. Yet this is too much like locking the stable after the theft of the horse fully to meet the case.

The real remedy for rapid and wasteful exhaustion of natural resources is to be found in technical and scientific research. The endowment of such research is one of the greatest financial problems of American industry. The state and federal governments have already provided for agriculture and applied foresight to the use of the public forests. The consolidation of iron ore properties under the control of a smaller number of large corporations is in itself a promise of a more economical method of handling them. But the real gain must come from the laboratory, whether in the iron and steel plant or in the experimental rooms of our universities and technical schools. The single item of applying electricity economically to the smelting of ores would in itself, for instance, be worth thousands of times the cost of experimentation and research in a single year's output.—*Wall Street Journal*.

ABSTRACTS FOR EVOLUTIONISTS

Madreporarian Corals.—In a magnificent work on the Madreporaria of the Hawaiian Islands and Laysan,¹ Dr. T. W. Vaughan takes up the difficult questions relating to the species and varieties of these animals, and while leaving them unsettled, gives a most interesting and suggestive discussion, with an abundance of facts, and very good illustrations, the latter occupying no less than ninety-six large plates. The following quotations will be of general interest:

Variation in corals is, we know, great and complex. If we knew its limits, we should know the limits of the different species. Bernard, in cataloguing the Perforate Corals of the British Museum (Natural History), experienced so much difficulty in defining them from the collections at his disposal that he decided to abandon the Linnaean system of nomenclature, and to use in his catalogues a geographical number system (p. 4).

Studies of variations, such as those contained in this paper, may appear elaborate to persons who have not gone deeply into the subject, but in reality they are of only a preliminary nature, for

¹ Bulletin 59, U. S. National Museum, 1907.

as stated in the introductory remarks, "there is on every side an insufficiency of data," and consequently it is not possible to solve many of the fundamental problems pertaining to the group. The study of variation is inseparable from experimental physiological investigations, for these are a necessary foundation for the understanding of variation (p. 6).

The author then goes on to distinguish between *gametic* and *vegetative* variation, and to outline the methods whereby these might be studied experimentally. He expresses the hope that the necessary investigations may be undertaken by the marine biological stations. Under *Porites compressa* (pp. 174-193) there is given a full account of twenty types of variation, called forms and subforms.

The variation appears to be continuous, but with a number of definite secondary modes, should they be plotted into a specific curve. . . . We have no facts by which it could be ascertained whether the differences are of gametic or vegetative origin.

Antarctic Pteropod Mollusca.—In the report of the British National Antarctic Expedition (1907), Sir Charles Eliot discusses the Pteropods of the southern seas, and calls attention to the fact that "in both the Arctic and Antarctic seas the predominant, and as we approach the Poles probably the only Pteropods are closely allied, or even identical species of *Limacina* and *Clione*." The distribution of these forms is interrupted by a wide zone in which they do not occur, none having been recorded from within thirty degrees either north or south of the equator. Sir Chas. Eliot remarks:

I confess that I have seen no explanation of these facts which appears to me satisfactory. Our knowledge of the direction in past ages of ocean currents which must have largely determined the distribution of pelagic forms is slight, and our record of fossil Pteropods is very imperfect (p. 3).

The Lizard-genus Leiolopisma.—Dr. L. Stejneger, in his recent admirable revision of the Reptiles and Amphibians of Japan,² gives an account of *Leiolopisma laterale* (Say), a lizard which in North America inhabits the lower Austral zone east of the Rocky Mountains, but is not found at all in the west. It

² Bulletin 58, U. S. National Museum, 1907.

reappears in Asia, occurring over a large area in China, and exists also in the Riu Kiu islands. The Chinese animal has been separated as *L. reevesii* (Gray), but Boulenger failed to find any distinctive characters to separate it, and Dr. Stejneger "upon the most searching comparison" has also utterly failed to discover any difference. The remaining species of the genus belong to the Old World. In speaking of the Scincidae in general, Dr. Stejneger says: "Many species have an enormous geographic range, owing to the ease with which they may be accidentally transported," but there is no reason to suppose that the distribution of *L. laterale* should be explained in that way. Probably many genera of lizards are of great antiquity. When recently at the Museum of Comparative Zoology I was shown by Mr. Samuel Henshaw a small lizard perfectly preserved in amber. Instead of being some strange extinct form, as one might have expected, it had all the appearance of a modern *Gekko*, and presumably belongs to that genus. It is scarcely necessary, of course, to refer to the fact that the case of *Leiolopisma* parallels several others known among plants, the molluscan *Philmopus*, etc., though the absolute specific identity is very remarkable, especially in a vertebrate.

A Mollusc New to Ireland.—Mr. J. W. Taylor³ has published a very interesting account of the discovery of *Vitrina elongata* (Draparnaud) in Ireland. It is a species which occurs commonly in the mountain regions of Central Europe, and also in Spain, and Mr. Taylor thinks it formerly had a much wider distribution, but has been driven out of many regions by stronger or more dominant species. Its survival in Ireland he attributes to the easier conditions (from the standpoint of the *Vitrina*) existing there.

A Grass Common to Ecuador and Guatemala.—In a recent account of some Guatemalan plants,⁴ Dr. B. L. Robinson and Mr. H. H. Bartlett call attention to the discovery of the anomalous genus of South American

³ Irish Naturalist, August, 1907.

⁴ Proc. Amer. Acad., June, 1907.

grasses, *Streptochaeta*, in Guatemala. The species proves to be *S. sodiroana* Hack, described from Ecuador, the determination having been confirmed by Professor Hackel himself:

This is by no means an isolated case of the occurrence of identical species in Ecuador and Guatemala, but it has peculiar interest from the marked character and rarity of the plant concerned (p. 50).

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

CURRENT NOTES ON METEOROLOGY AND CLIMATOLOGY

MONTHLY WEATHER REVIEW

Nos. 5 and 6, *Monthly Weather Review*, 1907, contain the following articles of the most general interest:

"Guilbert's Rules for Weather Prediction," by Dr. Oliver L. Fassig. Guilbert prepared a paper for the competition organized by the Belgian Astronomical Society, "in order to bring out the present state of the art of predicting the weather."

"Principles of Forecasting the Weather," by Gabriel Guilbert, of Caen. This sets forth the method followed by the writer, which is based on the principle of the *normal wind*. Those who are interested in weather forecasting, either practically or theoretically, will find this discussion worthy of serious attention.

"The Relation of the Movements of the High Clouds to Cyclones in the West Indies," by J. T. Quin; a further contribution to the discussion by the late Father Benito Viñes, prepared for the Chicago Meteorological Congress of 1893.

"Memorandum on the Gulf Stream and the Weather," by Professor Abbe; a sane statement of the extent to which the Gulf Stream does *not* affect our weather.

"The Cold Spring of 1907," by Professor A. J. Henry; a review of the weather map features which produced the cold weather of last spring, coupled with the following: "The underlying causes of the recent cold weather are probably obscure and deep seated."

"Value of Weather Forecasts to Natural

Gas Companies," in which the importance of forecasts of colder weather, with increased need of gas, is emphasized.

"Tornado at Wills Point, Texas, May 25, 1907," illustrated by two snap-shot photographs. Such photographs, although still rare, are fortunately becoming more numerous.

"Relations of the U. S. Weather Bureau to the Railroad Man," an address delivered by H. W. Richardson, local forecaster at Duluth, Minn., before the Northern Railway Club; contains notes on many interesting phases of the relation between weather and railroading.

"Legal Decisions as to Cyclones," being the opinion in full, of Judge Philips, of the United States Circuit Court of Appeals, Eighth Circuit, Minnesota.

"Hythers and the Comparison of Climates," by W. F. Tyler; a discussion of the question of sensible temperatures.

"Foehn in New South Wales," an extract from an account published in 1837.

"The St. Swithin's Day Fallacy," by J. H. Morrison. "It would seem to be almost useless to say anything further regarding the absurdity of the old superstition, with such an array of tell-tale figures all set against the legend."

"The Santa Ana of California," quotation from Professor Geo. E. Hale (*An. Vol. Carnegie Inst.*, 1906).

"Equinoctial Storms," by Professor E. B. Garriott. "There is no one special storm to which the term '*the equinoctial*' should be applied."

FORESTS AND RAINFALL

DR. J. SCHUBERT, director of the meteorological section of the Prussian Forestry School at Eberswalde, has recently published the results of his continued studies on forest influences in two papers. In one of these ("Der Niederschlag in der Setzlinger Heide," 1901-5; *Zeitschr. f. Forst und Jagdwesen*, 1907, No. 8) it is pointed out that of seventeen stations in forest, on the forest edge and in the open, the forest stations show a greater precipitation (1901-5), and the stations in the

open show the least. Corrections for snowfall and for difference in the exposure of the gauges as regards wind, amount to 5.5 per cent.; the observed difference in catch being 5.2 per cent. It thus appears that, as has previously been the case when the conditions of forest rainfall have been critically examined, the probability of error is about equal to the apparent difference in the amount of precipitation.

The second paper ("Wald und Niederschlag in Westpreussen und Posen und die Beeinflussung der Regen und Schneemessung durch den Wind," *ibid.*, 1906, No. 11) is a critical study of the effect of wind on the catch of precipitation, especially snow, in gauges.

INFLUENCE OF FORESTS UPON WIND VELOCITY

M. I. ST. MURAT, the new director of the Meteorological Institute of Roumania, has made a study of the retarding effect of forests upon wind velocity (Bucharest, 1907, 4to, pp. 33, pls. 3), which appears in the *Annales* of the Roumanian Academy, Bucharest. The subject is one which has hitherto received practically no attention, at least so far as quantitative measurements are concerned. The results are as follows: The greatest effect which a forest can have upon the wind consists in diminishing the wind velocity to leeward of the forest. At 50 meters (164 feet) this decrease in velocity may amount to 3 to 12 kilometers (4-7½ miles) an hour, which means a reduction of the force of the wind by one degree on the Beaufort scale. This decrease is felt within 100 meters (330 feet) of the forest. After that the velocity increases again with increasing distance, and at about 500 meters (1,640 feet) reaches the force noted before the forest was encountered.

THUNDERSTORMS AND "FALSE CIRRUS"

DR. C. KASSNER has investigated the question of the "false cirrus" and of solar haloes ("Gewitterschirm und Sonnenringe," *Met. Zeitschr.*, July, 1907), with the following result:

1. Solar haloes before and after thunderstorms show that the cirrus veil is an ice cloud.

2. It is therefore wrong and misleading to call these cirrus clouds "false cirrus."

3. The cirrus cloud veil precedes the thunderstorm on the average by as much as four hours, and follows it by about one hour. Hence the average extent is measured by five hours, or, with an average hourly velocity of progression of 25 miles, the distance covered is 125 miles.

CLIMATOLOGY OF SOUTH AFRICA

J. R. SUTTON, meteorologist of the De Beers Consolidated Mines, Kimberley, has published three more papers dealing with the climate of his district. These are (1) "A Contribution to the Study of Evaporation from Water-surfaces" (*Sci. Proc. Roy. Dub. Soc.*, XI., N. S., No. 13, 1907, 137-178); (2) "Variability of Temperature in South Africa," and (3) "The Diurnal Variation of Barometric Pressure" (*Rept. So. Afr. A. A. S.*, 1906, 13-48; 135-142). These papers are all worthy of attention on the part of those interested in the general subjects treated, or in the climatology of South Africa in particular.

THE WEATHER BUREAU

AN account of the various activities of the Weather Bureau in saving life and property is given in an article by Gilbert H. Grosvenor, entitled "Our Heralds of Storm and Flood," published in the *National Geographic Magazine* for September, 1907. This article, which is fully illustrated, originally appeared in the *Century*.

SALT OF MARINE ORIGIN IN THE ATMOSPHERE

A PAPER entitled "Quelle est l'Importance du Transport atmosphérique de Sel marin?" by E. Dubois, published in *Ciel et Terre*, July 16, 1907, is worth noting chiefly because of the bibliographical notes which accompany it.

R. DEC. WARD

HARVARD UNIVERSITY

THE DISTRIBUTION OF RADIUM IN THE ROCKS OF THE SIMPLON TUNNEL¹

THE principal classes of material which enter into the composition of the massif of the

¹ Read before Section C, British Association for the Advancement of Science, Leicester, 1907.

Simplon are: (a) The Jura-Trias sediments, lithologically often much alike and much interfolded; (b) the Paleozoic crystalline schists; and (c) the gneiss of Monte Leone and the Antigorio gneiss, both stated to be of Archæan age. These rocks throughout contain radium, and for the most part in quantities much above what hitherto has been ascribed to sedimentary or igneous rocks.

Some thirty-six typical samples, taken from various points in the tunnel, have been examined. The poorest in radium are certain anhydrite rocks. Certain amphibolite schists go very high. The Antigorio gneiss rises from 10.5×10^{-12} and 8.0×10^{-12} grams radium per gram of rock at the Italian entrance to 23.7×10^{-12} at 4,000 meters inwards. Some of the Archæan gneisses yielded very high results.

Such quantities of radium if generally distributed throughout the rocks of the massif would be sufficient to disturb any forecast of the temperature which under normal conditions would be encountered at the level of the tunnel. It is suggested that the radium was in fact the source of the discrepancy between the predicted and the observed rock temperatures.

As it is improbable that these results are unique and apply only to this particular sedimentary accumulation and locality, they appear to point to hitherto unsuspected quantities of radium (and its parent elements) in the immediate surface materials of the earth. It seems impossible to avoid the conclusion that these elements were precipitated along with the sediments entering into the composition of the massif. The question then arises whether the accumulation of such quantities of radioactive elements may not enter as a factor in the events attending mountain-building. It can be shown that an area of sedimentation whereon has been accumulated some 10,000 meters of sediments, having a richness in radium comparable with the Simplon rocks, must necessarily become an area of greatly lessened crust-rigidity, and would hence become the probable site of crust-flexure under tangential compressive stress.

Further investigation will be required be-

fore such views can be generalized and the importance of radium as a source of instability of the earth's crust be determined. Apart from any speculations as to the influence of radium as the cause of an energetic substratum, the shifting of radium and its parent elements by denudation must be regarded as a convection of thermal energy, and this convection, if the quantities involved are sufficient, must, under the conditions referred to above and the unceasing action of denudation, become rhythmic in operation, and at the same time must result in shifting the areas of high temperature and crust-weakness from age to age as the site of sedimentary accumulation changes.

J. JOLY

THE ARC OF PERU

THE Committee of the French Academy of Sciences having scientific control of the French Geodetic operations on the equator has reported the completion of the remeasurement of the historic arc of Peru.¹

This arc was measured by the French (1736-1743) and used in connection with a similar arc in the Arctic regions, also measured by the French, to decide a question in regard to the form of the earth which had arisen as the result of Cassini's surveys in France.

A discussion of the measurement of the arc can be found in the report of the Superintendent of the Coast and Geodetic Survey for 1889, appendix 7.

In 1889, the question of remeasuring this arc was brought before the International Geodetic Association by the Delegate of the United States, Professor George Davidson, who suggested that France should have the prior right to execute the work.

Circumstances prevented any active work until 1898, when the discussion of the subject was renewed in the same association as the result of a motion offered by the Delegate of the United States, Mr. E. D. Preston. The association voted in favor of the proposition to remeasure the arc and the French delegates undertook to have the work done.

¹ *Comptes Rendus Hebdomadaires des Séances de L'Académie des Sciences*, No. 6, 5 Aout, 1907.

Officers of the Geographic Service of the French Army left Paris for Ecuador in May, 1899, and the work was continued until completed.

The arc extends from Tulcan, Ecuador, Lat. $+0^{\circ} 48' 25''.6$ to Payta, Peru, Lat. $-5^{\circ} 05' 08''.6$ and the work accomplished in the remeasurement may be summarized as follows; viz.:

Seventy-four geodetic stations.

Three base lines measured.

Eight differences of longitude determined between stations at Tulcan, Piular, Quito, Latacunga, Riobamba, Cuenca, Machala, and Payta. The first five of these stations are distributed along the northern section of the arc, the sixth at the middle of the southern section, the seventh on the coast at the same latitude as the sixth, and the last at the end of the southern section, on the coast.

The comparison of the differences of longitude, geodetic and astronomic, between the stations at Machala and Payta and the station at Cuenca will throw light on the form of the geoid, as the first two stations are on the coast and the third is in the inter-andine region.

Six azimuths determined: at Tulcan, Piular, Quito, Riobamba, Cuenca, and Payta.

Sixty-four determinations of latitude.

Forty-eight magnetic stations: distributed all along the arc.

Six pendulum stations. One of these is at Machala, on the coast, at the point where observations for longitude were made; one at the foot of the western Cordillera, near Chimborazo; one, at an elevation of 4,150 meters in the western Cordillera; two, in the inter-andine region at Riobamba and Quito; and one at an altitude of 1,800 meters in the plain of the Amazon on the eastern slope of the eastern Cordillera.

Two lines of levels of precision: one from the Riobamba base line to Guayaquil and to the tide gauge at Salinas on the Pacific Coast and the other from the southern base line to the tide gauge at Payta, the two lines covering a distance of 410 kilometers.

A study was made of the natural history of

the country and important collections were made, which will add to the knowledge of botany, zoology, anthropology and ethnology.

The preliminary computations are far enough advanced to assure the value of the observations. The closure of the triangles and the agreement of the computed and the measured lengths of the base lines compare well with the results obtained in the revision of the meridian of France.

The publication of the results of the work will be regarded as an important event by geodesists throughout the world.

The work reflects great credit on the French government for its liberality in providing the necessary funds, upon the French savants who directed the work and upon the gallant officers who made the scientific observations under most trying and unusual conditions.

ISAAC WINSTON

REPORT OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE¹

THE International Commission on Zoological Nomenclature has the honor to submit the following report to the Seventh International Zoological Congress:

The Sixth International Congress referred to the Commission for consideration and report a paper (presented to that congress) urging that "absolute priority" be adopted in the law of priority, instead of taking 1758 as a starting point for zoological nomenclature.

While appreciating the sentiments which gave rise to the proposition in question, your commission is unanimously of the opinion that both practical and theoretical considerations contravene the adoption of "absolute priority" in preference to the date 1758. Accordingly, it is herewith recommended that article 26 of the code be not changed in respect to the point at issue.

During the past three years, several zoologists have submitted to the commission propo-

¹ Presented to the Seventh International Zoological Congress, Boston, Mass., August 19-23, 1907, and unanimously adopted after two public readings.

sitions for amendments or additions to the code. In accordance with the rule established by the Cambridge Congress, a number of these propositions could not be considered formally, because they did not reach the commission at least one year prior to the meeting of the present congress.

In its deliberations, the commission decided to report to the congress only those propositions upon which the vote in commission, as assembled here, was unanimous. The following propositions are unanimously recommended for adoption:

Add to Art. 8 the following:

RECOMMENDATION.—Certain biological groups which have been proposed distinctly as collective groups, not as systematic units, may be treated for convenience as if they were genera, but they require no type species. Examples: *Agamodistomum*, *Amphistomulum*, *Agamofilaria*, *Agamomermis*, *Sparganum*.

Add to Art. 14 the following:

RECOMMENDATION.—It is well to avoid the introduction of the names *typicus* and *typus* as new names for species or subspecies, since these names are always liable to result in later confusion.

Add to Art. 20 the following:

RECOMMENDATION.—In proposing new names based upon personal names which are written sometimes with ü, ö or ÿ, at other times with æ, œ and ue, it is recommended that authors adopt æ, œ and ue. Example: *muelleri* in preference to *müllerri*.

Add to Art. 29:

RECOMMENDATION.—To facilitate reference, it is recommended that when an older species is taken as type of a new genus, its name should be actually combined with the new generic name, in addition to citing it with the old generic name. Example: *Gilbertella* Eigenmann, 1903, Smithsonian Misc. Coll., v. 45, p. 147, type *Gilbertella alata* (Steindachner) = *Anacyrtus alatus* Steindachner.

Strike out the entire Art. 30 (dealing with the designation of type species of genera) and substitute therefor the following:

Art. 30.—The designation of type species of genera shall be governed by the following rules (a-g), applied in the following order of precedence:

I. Cases in which the generic type is accepted solely upon the basis of the original publication—

(a) When in the original publication of a genus, one of the species is definitely designated as type, this species shall be accepted as type regardless of any other considerations. (Type by original designation.)

(b) If, in the original publication of a genus, *typicus* or *typus* is used as a new specific name for one of the species, such use shall be construed as "type by original designation."

(c) A genus proposed with a single original species takes that species as its type. (Monotypical genera.)

(d) If a genus, without originally designated (see a) or indicated (see b) type, contains among its original species one possessing the generic name as its specific or subspecific name, either as valid name or synonym, that species or subspecies becomes *ipso facto* type of the genus. (Type by absolute tautonomy.)

II. Cases in which the generic type is not accepted solely upon basis of the original publication—

(e) The following species are excluded from consideration in selecting the types of genera:

(a) Species which were not included under the generic name at the time of its original publication.

(b) Species which were *species inquirendæ* from the standpoint of the author of the generic name at the time of its publication.

(γ) Species which the author of the genus doubtfully referred to it.

(f) In case a generic name without originally designated type is proposed as a substitute for another generic name, with or without type, the type of either, when established, becomes *ipso facto* type of the other.

(g) If an author, in publishing a genus with more than one valid species, fails to designate (see a) or to indicate (see b, d) its type, any subsequent author may select the type, and such designation is not subject to change. (Type by subsequent designation.)

The meaning of the expression "select a type" is to be rigidly construed. Mention of a species as an illustration or example of a genus does not constitute a selection of a type.

III. RECOMMENDATIONS.—In selecting types by subsequent designation, authors will do well to govern themselves by the following recommendations:

(h) In case of Linnæan genera, select as type

the most common or the medicinal species. (Linnaean rule,² 1751.)

(i) If a genus, without designated type, contains among its original species one possessing as a specific or subspecific name, either as valid name or synonym, a name which is virtually the same as the generic name, or of the same origin or same meaning, preference should be shown to that species in designating the type, unless such preference is strongly contraindicated by other factors. (Type by virtual tautonomy.) Examples: *Bos taurus*, *Equus caballus*, *Ovis aries*, *Scomber scombrus*, *Sphaerostoma globiporum*; contraindicated in *Dipetalonema* (compare species *Filaria dipetala*, of which only one sex was described, based upon one specimen and not studied in detail).

(j) If the genus contains both exotic and non-exotic species from the standpoint of the original author, the type should be selected from the non-exotic species.

(k) If some of the original species have later been classified in other genera, preference should be shown to the species still remaining in the original genus. (Type by elimination.)

(l) Species based upon sexually mature specimens should take precedence over species based upon larval or immature forms.

(m) Show preference to species bearing the name *communis*, *vulgaris*, *medicinalis* or *officinalis*.

(n) Show preference to the best described, best figured, best known, or most easily obtainable species, or to one of which a type specimen can be obtained.

(o) Show preference to a species which belongs to a group containing as large a number of the species as possible. (De Candolle's rule.)

(p) In parasitic genera, select, if possible, a species which occurs in man or some food animal, or in some very common and wide-spread host-species.

(q) All other things being equal, show preference to a species which the author of the genus actually studied at or before the time he proposed the genus.

(r) In case of writers who habitually place a certain leading or typical species first as "chef de file," the others being described by comparative

² Si genus receptum, secundum jus naturæ et artis, in plura dirimi debet, tum nomen antea commune manebit vulgatissimæ et officinali plantæ.

reference to this, this fact should be considered in the choice of the type species.

(s) In case of those authors who have adopted the "first species rule" in fixing generic types, the first species named by them should be taken as types of their genera.

(t) All other things being equal, page precedence should obtain in selecting a type.

OPINIONS RENDERED BY THE COMMISSION.—In response to certain questions, especially in reference to the Law of Priority (Art. 25) and its application (Art. 26), submitted for consideration, the Commission herewith unanimously renders the following opinions:

The meaning of the word "indication" in Art. 25a.—The word "indication" in Art. 25a is to be construed as follows:

(A) with regard to *specific* names, an "indication" is (1) a bibliographic reference, or (2) a published figure (illustration), or (3) a definite citation of an earlier name for which a new name is proposed.

(B) with regard to *generic* names, (1) a bibliographic reference, or (2) a definite citation of an earlier name for which a new name is proposed, or (3) the citation or designation of a type species.

In no case is the word "indication" to be construed as including museum labels, museum specimens or vernacular names.

The Nature of a Systematic Name.—The Commission is unanimously of the opinion that a *name*, in the sense of the Code, refers to the designation by which the actual objects are known. In other words, we name the objects themselves, not our conception of said objects. Names based upon hypothetical forms have, therefore, no status in nomenclature and are not in any way entitled to consideration under the law of priority. Examples: *Pithecanthropus* Haeckel, 1866, being the name of an hypothetical genus, has no status under the Code and does not therefore invalidate *Pithecanthropus* Dubois, 1894; *Gigantopora minuta* Looss, 1907, *n. g., n. sp.*, has no status under the code, since it is admittedly the name of a fantastic unit, not based upon any actual objects.

The Status of Publications Dated 1758.—The tenth edition of Linné's "Systema

"Naturæ" was issued very early in the year 1758. For practical reasons, this date may be assumed to be January 1, 1758, and any other zoological publication bearing the date 1758 may be construed as having appeared subsequent to January 1. In so far as the date is concerned, all such publications may therefore be construed as entitled to consideration under the law of priority.

Status of Certain Names Published as Manuscript Names.—Manuscript names acquire standing in nomenclature when printed in connection with the provisions of Art. 25, and the question as to their validity is not influenced by the fact whether such names are accepted or rejected by the author responsible for their publication.

Status of Certain Pre-Linnæan Names Reprinted Subsequent to 1757.—A pre-Linnæan name, ineligible because of its publication prior to 1758, does not become eligible simply by being cited or reprinted with its original diagnosis after 1757. To become eligible under the code, such names must be reinforced by adoption or acceptance by the author publishing the reprint. Examples: The citation, subsequent to 1757, of a bibliographic reference to a paper published prior to 1758 does not establish technical names which may appear in said reference; synomeric citation of pre-Linnæan names, as in the tenth edition of Linné's "Systema Naturæ," does not establish such names under the code.

CH. WARDELL STILES,
Secretary

WILBUR OLIN ATWATER

As the outcome of an illness lasting nearly three years, Professor Wilbur Olin Atwater died at his home in Middletown, Conn., on the evening of September 22, 1907. Professor Atwater was born in Johnsburgh, N. Y., on May 3, 1844. After three years of undergraduate life as a student in the University of Vermont, he spent his senior year at Wesleyan University, graduating in 1865. Several years were spent in teaching in high schools and he then devoted some time to the study of chemistry at the Sheffield Scientific

School, receiving the degree of Doctor of Philosophy from Yale University in 1869. His thesis dealt with the composition of several varieties of American maize, thus early showing his tendencies to agricultural science—tendencies that were stimulated by further study at foreign universities in Leipsic and Berlin.

On return from foreign study, he was successively called to professorships in the East Tennessee University, Maine State College, and Wesleyan University. Taking up his work at this latter institution in the then new Orange Judd Hall of Natural Sciences, he began to prosecute researches particularly in the field of agricultural chemistry, enlisting the cooperation of the farmers and awakening interest in the rapidly developing chemistry of fertilizers. This active interest in agricultural chemistry he retained until his death. Recognizing the great service to agricultural science resulting from the experiment stations in Germany, he founded at Wesleyan University the first American agricultural experiment station in 1875. This station was subsequently removed to New Haven and is there continued as the Connecticut Agricultural Experiment Station. In 1888, the Storrs (Conn.) Agricultural Experiment Station was organized and Professor Atwater was appointed its director, a position he held until 1902.

The rapid development of the experiment station movement soon showed that some central clearing house was necessary to give the results of the various stations proper publicity, to promote cooperation among the various experiment station workers and to prevent as far as possible unnecessary duplication of work. To this end, the Office of Experiment Stations of the U. S. Department of Agriculture was created and Professor Atwater was appointed its first director.

It was a natural transition from the study of animal feeding to that of the feeding of man and soon Professor Atwater was directing his energies to chemical and statistical researches on the food and nutrition of man. His early experience as special agent of the U. S. Department of Labor developed in his

mind to a high degree the importance of the social and economic study of the relations of food and diet to the labor power, health and moral tone of communities and the scientific studies of dietaries begun in a small way developed into a large investigation of the dietary conditions obtaining in various parts of the United States. Special appropriations were secured from Congress to study the nutrition of man and the whole enterprise soon partook of the nature of an extensive cooperative study of food and diet. These studies were carried out with the active assistance of various investigators in numerous universities and colleges and they extended literally from Maine to California.

In company with his colleague, Dr. E. B. Rosa, he developed at Wesleyan University a respiration calorimeter for experiments with man, in which many researches into the fundamental laws of metabolism have been made. Perhaps the investigation of greatest theoretical interest is the series of experiments made with this apparatus demonstrating that the law of the conservation of energy obtained in the physiological transformations of the living body.

An investigation into the nutritive value of alcohol made with this apparatus by the aid of grants from the Committee of Fifty for the Investigation of Alcohol attracted much notice, both in America and in Europe, and Professor Atwater soon began an active campaign in the interest of rational temperance reform.

Professor Atwater was a member of a large number of scientific societies and kindred institutions. He was a foreign member of the Swedish Royal Academy of Agriculture and a corresponding member of the Russian Imperial Military Academy. His chemical, agricultural and economic writings have been translated into several foreign languages and few American scientists were better known abroad than was he. His writings number somewhat over 100 papers and cover a large field.

It was perhaps as an administrative officer and organizer that Professor Atwater rendered the greatest service to American science, and

he will always be noted for the establishment of the experiment station movement. As the first director of the Office of Experiment Stations, he chose as his assistants Dr. A. W. Harris, now president of Northwestern University, who became his immediate successor, and Dr. A. C. True, now director of the Office of Experiment Stations. Thus, in large measure, the policy which he inaugurated has been continued from the creation of this office.

Of remarkable activity and energy, Professor Atwater attracted many young men to his laboratory and his loss will be especially felt by all those who have had the good fortune to have come under his influence during his active career as a director of research for more than thirty years.

F. G. B.

SCIENTIFIC NOTES AND NEWS

THE memorial statue of Joseph Leidy, the eminent anatomist and zoologist, erected on the west side of the City Hall Plaza, Philadelphia, will be unveiled at 3 P.M. on Wednesday, October 30. Addresses will be made by Mr. Joseph Wharton and Professor Henry C. Chapman, M.D.

DR. G. HELLMANN has been appointed professor of meteorology in the University of Berlin and director of the Prussian Meteorological Service, in succession to the late Professor von Bezold.

ON the occasion of the recent celebration of the centenary of the Geological Society of London, the gold medal of the Institution of Mining and Metallurgy was presented to Sir Archibald Geikie, the president of the society.

PRESIDENT HADLEY, of Yale University, has sailed for Germany, to spend six months as Roosevelt professor of American history and institutions in the University of Berlin, on the Columbia University foundation.

DR. ROBERT F. WEIR and Dr. Charles McBurney, professors of clinical surgery, have been made emeritus professors of surgery at the College of Physicians and Surgeons, Columbia University.

DR. G. N. STEWART, professor of physiology at Western Reserve University, has leave of

absence during the present academic year, which he will spend in research in Vienna.

PROFESSOR GEORGE F. FULLERTON, professor of philosophy in Columbia University, has been given leave of absence and is spending the present year at Munich. His courses are given by Professor Arthur O. Lovejoy, of Washington University.

PROFESSOR WILLIAM A. HAMMOND, of Cornell University, will lecture throughout the year at the University of Pennsylvania on ancient and medieval philosophy.

MR. C. C. ROBERTSON, of the Yale Forestry School, after a tour of the European forests, will engage in government forestry work in Orange River Colony, South Africa.

PROFESSOR AUSTIN CARY, of Harvard University, has been engaged by the Maine State Forestry Commission for a series of lectures covering several weeks, during which time he will speak before granges, schools and other audiences in cities and towns in all parts of the state. Professor Cary will commence his tour during the first week of November.

DR. A. A. MACDONELL, Boden professor of Sanskrit at Oxford, has left England on leave of absence for India and Ceylon in furtherance of Sanskrit research. All the most important Sanskrit libraries, archeological sites and museums, and university colleges in India and Ceylon will be visited, and conferences will be held with native scholars. One of the objects of the tour is to acquire old Sanskrit manuscripts where opportunity offers, and another to collect material for a Dictionary of Indian Religion and Mythology, illustrated and treated historically.

DR. GEORGE BYRON GORDON, curator of the section of American archeology at the Museum of Arts and Sciences of the University of Pennsylvania, has been making explorations among the Indian tribes of Alaska, and has secured many valuable specimens.

DR. WILLIAM H. NICHOLS, chairman of the board of directors of the General Chemical Company, gave the address at the Founder's Day celebration at Lehigh University on October 10.

DR. JOSEPH W. RICHARDS, of Lehigh University, lectured before the Franklin Institute of Philadelphia, on October 10, on the "Thermo-electric Production of Iron and Steel."

BIRMINGHAM UNIVERSITY has arranged a course of lectures during the coming session, especially in the interests of the industrial classes, on the lines followed in an experimental series last winter. The principal, Sir Oliver Lodge, will deal in five divisions with "Pioneers of Science," and other lectures will be delivered by Professor J. H. Poynting, Professor C. Lapworth and Professor T. Turner. Some of the subjects included in the lectures have special reference to local industries.

A COURSE in experimental physiology, under the direction of Professor Graham Lusk, is offered to teachers on Fridays at three o'clock, at University and Bellevue Hospital Medical College, 338 East 26th street, New York City.

THE program of the Harvey Society course of lectures for the coming year is as follows:

October 26—Professor E. O. Jordan, University of Chicago: "The Problems of Sanitation."

November 16—Professor James Ewing, Cornell University: "Etiology of Tumors."

November 30—Professor D. L. Edsall, University of Pennsylvania: "The Bearing of Metabolism Studies on Clinical Medicine."

January 11—Professor Ernest H. Starling, University of London: "The Chemical Control of the Body."

January 25—Professor George W. Crile, Western Reserve University: "Shock."

February 8—Professor Joseph Jastrow, University of Wisconsin: "Subconsciousness."

February 22—Professor Otto Folin, Harvard University: "Problems of Chemistry in Hospital Practise."

March 7—Professor Ross G. Harrison, Yale University: "Embryonic Transplantation and the Development of the Nervous System."

April 11—Professor E. A. Schäfer, University of Edinburgh: "Artificial Respiration in Man."

The lectures are given under the patronage of the New York Academy of Medicine and are held at the Academy Building, 17 West 43d street, on Saturday evenings at 8:30

o'clock. All interested are cordially invited to attend them.

THE committee on the Mary Putnam Jacobi fellowship announces that \$8,000 of the \$25,000 required has been raised. The fund is expected to provide an income of \$1,000, whereby efficient aid may be rendered to post-graduate women students in medicine. The Women's Medical Association of New York City invites the cooperation of all who desire to further the higher medical education of women in medicine. The treasurer of the association is Dr. Eleanor Tomes, 136 East Thirtieth street.

PROFESSOR CHARLES STEWART, F.R.S., for the past twenty-three years conservator of the museum of the Royal College of Surgeons of England, died on September 27. He was also for a long time Hunterian professor of human and comparative anatomy at the college, and had been Fullerian professor of physiology at the Royal Institution.

THE Berlin Cancer Institute, which is under the direction of Professor von Leyden, is to be considerably enlarged. New laboratories for the investigation of cancer will, it is announced, be built in a house in the neighborhood of the Charité Hospital.

THE New England Federation of Natural History Societies met in Portland, Me., on Friday and Saturday, October 4 and 5. The federation was the guest of the Portland Society of Natural History, an old association of which Stimpson, Mighels, Fuller and Morse were earlier members. About twenty delegates were present, representing as many of the affiliated associations. Exhibits were shown by the Appalachian Mountain Club of Mount Washington flora; Dr. D. W. Fellows, ferns and grasses of Maine; Mrs. J. H. Lewis, moths of Maine; Fairbanks Museum, St. Johnsbury, Vt., alpine plants; J. H. Emerton, Boston, spiders; Miss Cherrington and Miss Clapp, of Boston, mosses of New England, and others. The meeting of Friday evening was by the Portland society, with President Leslie A. Lee, of Brunswick, in the chair, Major J. W. Boyd (archeology) and J. H. Emerton

(spiders) being the speakers. On Saturday evening the meeting was of the federation, with Miss Delia I. Griffin, of St. Johnsbury, on the relations between the small museum and the school children, and Miss M. Edna Cherrington on mosses. On Saturday afternoon a joint outing of the society and the federation made a trip to the shore, where more than a score of unusual species were found in the tide-pools. On Sunday, on invitation of Professor Lee, the delegates visited the museums and laboratories of Bowdoin College. The president of the federation is John Ritchie, Jr., and the secretary, J. H. Emerton, both of Boston. The annual meeting of the federation is set for April, in Boston, and a special meeting will be convened the first week in July on the summit of Mount Washington, where an unusual opportunity will be afforded to study the fauna, flora, topography and geology of the presidential range.

THE seventh Annual Conference of the Sanitary Officers of the State of New York, under the auspices of the New York State Department of Health, will be held at Buffalo from October 16 to 18. There will be an opening address by Dr. Eugene H. Porter, commissioner of health, and by Governor Hughes. A number of papers of scientific importance will be presented during the six following sessions of the congress.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JOHN D. ROCKEFELLER has undertaken to triple gifts made for the memorial library to be erected at the University of Chicago in honor of William Rainey Harper. The sum of \$110,000 has been subscribed for the memorial from various sources, and Mr. Rockefeller has given \$330,000. He will triple further gifts, not exceeding \$90,000, thus making his total contribution \$600,000.

PROFESSOR JOHN HAYES HAMMOND has given an additional \$5,000 for the further equipment of the Hammond Metallurgical Laboratory of the Sheffield Scientific School of Yale University. This makes Professor Hammond's gift to the laboratory \$127,000. The Sheffield Sci-

entific School has also received a gift of \$1,000 a year, for ten years, from an anonymous donor, a member of the class of '95 S., to be used for the course in commercial geography.

THE Johns Hopkins University has received \$20,000 by the will of the late Miss Frances Wilson, of New York.

MRS. GEORGE E. WHEELOCK has given \$5,000 to Columbia University as a fund in memory of her late husband, the income to be applied to the benefit of the Department of Physiology. Columbia University has also received \$5,000 from Mr. Bernard M. Baruch for the Vanderbilt Clinic.

MR. ANDREW CARNEGIE has given £10,000 towards the establishment of a technical college at Aberdeen.

THE board of regents of the University of Kansas have recently let the contract for the first of a group of five new buildings for the School of Engineering. Two more buildings of the group will be started next year, when the money appropriated by the legislature becomes available. The Robinson Gymnasium, erected at a cost of \$100,000, was opened for use on October 10.

THE new laboratories of the scientific departments of the College of Liberal Arts of Boston University have been opened in the building formerly occupied by the Harvard Medical School and adjoining the Public Library. The top floor is occupied by the departments of astronomy, physics and mathematics, and comprises large and small lecture rooms, laboratories and offices; a large part of the basement is also given over to physics. The chemical and the biological departments occupy the second floor, and consist of large, admirably-lighted class laboratories, private laboratories and store rooms, professors' rooms and an amphitheater for the larger classes. The two domes for the telescopes of the astronomical department are situated on the roof and are not quite completed. The equipment of all the laboratories is new and was purchased in part by special funds donated to the university for that purpose. A large passenger elevator makes all the floors

of the building readily accessible. The scientific departments are under the same directors as last year: Professor J. B. Coit in astronomy and mathematics; Professor N. A. Kent in physics; Professor L. C. Newell in chemistry, and Professor A. W. Weysse in biology.

WESTERN RESERVE UNIVERSITY is one of the three institutions in the United States requiring for entrance to its medical department the equivalent of three years in a standard college of arts or science. The four years' course includes required, systematic work in the laboratories of anatomy and histology, pathology, physiology, bacteriology, pharmacology and clinical microscopy. Since instituting the high college requirement for admission, only laboratory work in advanced and physiological chemistry under the charge of the departments of physiology and biochemistry has been given in this school. The five-story building now being erected will provide laboratories for the new department of experimental medicine established by the Payne-Hanna gift of \$200,000. Alterations and improvements have been completed at Lakeside Hospital, one of the hospitals affiliated with Western Reserve University.

THE plan of reorganization of the School of Agriculture of the Pennsylvania State College provided for the separation of the collegiate instruction in agricultural chemistry and the work of investigation in that field of science, the two departments thus formed being designated respectively as the department of agricultural chemistry and the department of experimental agricultural chemistry. It has already been announced that the latter portion of the work has been retained by Professor Frear, who, it is expected, will also offer some post-graduate courses of instruction. It is now announced that the professorship of agricultural chemistry has been filled by the election of Professor Charles Lyndall Penny, A.M., lecturer in agricultural chemistry to the Delaware Agricultural College, and for many years chemist to the Delaware Experiment Station. Margaret B. MacDonald, Ph.D., (Bryn Mawr) has been appointed to the position of instructor in agricultural chemistry.

THE chair of assaying in the Massachusetts Institute of Technology, vacant by the resignation of Professor Richard W. Lodge to become a consulting engineer, has been filled by the appointment of Professor Edward E. Bugbee, who graduated from the institute in 1900, and has since been teaching in the University of Iowa and the University of Washington.

THE chair of mathematics at the Thomas S. Clarkson Memorial School of Technology, Potsdam, N. Y., has been filled by the appointment of Samuel G. Barton, Ph.D. (Pennsylvania), Harrison fellow at the University of Pennsylvania, 1905-1906, and research fellow in astronomy, 1906-1908.

DR. LEON J. COLE, chief of the division of animal breeding and pathology of the Rhode Island Experiment Station, has been appointed instructor in zoology in Yale University. Lorande Loss Woodruff, Ph.D. (Columbia), instructor in Williams College, has been appointed instructor in biology at the same institution. Mr. Henry J. Spencer, of Syracuse University, succeeds Dr. Woodruff as instructor in biology at Williams.

DR. FRANK PIERPONT GRAVES, of the University of Missouri, has been appointed professor of the history and principles of education at the Ohio State University. Dr. Guy Montrose Whipple, assistant professor of education at Cornell University, has been appointed acting professor of education at Missouri.

THE following new appointments have been made at the University of Kansas: F. H. Billings, associate professor of botany; Adolf Zeifle, assistant professor of pharmacy; J. E. Todd, assistant professor of geology; H. L. Jackson, assistant professor of chemistry; P. A. Glenn, assistant professor of entomology; Charles Oshwald, instructor in mechanical engineering; J. B. Carter, instructor in physiology; Burton McCullum, instructor in physics; Frank Rupert, assistant instructor in chemistry; Thomas Haslam and Florence Hazen, assistants in chemistry; W. A. Starin, instructor in botany; W. B. R. Robinson, assistant instructor in zoology. Associate

Professor M. E. Rice has been made acting head of the department of physics; the chair of physics is vacant and will probably be filled some time during the year.

AT Washington and Lee University, the Rev. J. Howerton, D.D., has been made professor of philosophy in the place of Dr. A. Quarles, who died in April; and Dr. Thomas K. Urdahl, Ph.D. (Wisconsin, '97), professor of political and social science in Colorado College, has been elected to the chair of political economics and political science, vacant by the removal of Dr. H. T. Willis to the George Washington University. The other changes in the teaching corps are among the assistants, most of whom are changed annually. In physics, Frederic Bartenstein becomes head assistant, with E. K. Paxton and R. W. Dickey as junior assistants. In chemistry, Wm. H. Marquess is head assistant, with A. P. Lee, E. H. Deets and A. W. Lybrand as junior assistants. In biology, W. P. Hooper is assistant. In engineering, E. A. Hoge is assistant. In mathematics, R. Ragland and J. W. Addison are assistants. Of this list Messrs. Bartenstein, Marquess and Lee are reappointments.

THE following changes occur in the Scientific Department of the University of Maine this year: W. D. Hurd promoted from acting dean to dean of the College of Agriculture; L. H. Merrill, professor of biological and agricultural chemistry; C. P. Weston promoted to professor of mechanics and drawing; Dr. M. A. Chrysler, associate professor of botany; C. B. Brown, promoted to assistant professor of civil engineering; Herman Beckenstrater, assistant professor of horticulture; J. E. McClintock, in charge of the agricultural extension work; W. M. Curtis, assistant professor of mechanical engineering; H. R. Willard, promoted to an assistant professorship of mathematics; D. J. Edwards, promoted to an instructorship in botany; P. L. Bean, L. I. Johnstone, and A. R. Lord, instructors in civil engineering; R. E. Clayton, J. Seymour and W. F. Washburn, instructors in chemistry; H. W. Bearce promoted to an instructorship in physics; C. C. Murdock, tutor in physics; and C. S. Winch, taxidermist in the museum.